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Horticulture research in Central Asia: A review of papers from the Scopus database published from 2000 to 2020

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Abstract. Horticulture crops (fruit trees) had been grown and cultivated from ancient times in Central Asia. Few researchers have addressed the problem of this profitable sector in the former Great Silk Road, which was at the crossroads of trading avenues. Horticulture has received much attention in the last twenty years. To investigate the current state of research activity of horticulture in Central Asia, we downloaded 4205 English papers from the Scopus database between 2000-2020. We identified a total of 50 papers, and the last four years have witnessed significant growth in publication number, an average of 5 articles per year. Acta Horticulturea was one of the most productive journals. Institute of Plant Biology and Biotechnology (Almaty) and the Academy of Sciences of the Republic of Uzbekistan have worked productively to study high issues. United States Department of Agriculture and Swiss National Science Foundation with Karl Popper Foundation have supported scientific activity in the region. Top 15 highly cited articles were published within funded projects with international researchers. Researchers of Central Asia focused on walnut, grape, and apple, studied on the molecular level, and cryopreservation of wild relatives for future use. Researchers less studied cherry, apricot, almond, and pomegranate crops.

Key words: Central Asia, bibliometric analyses, horticulture, science.

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1. Introduction

Horticulture is the art and science of growing fruits, vegetables, herbs, nuts, and ornamental crops and terminology which has a Latin root, "Hortus" means garden and "Colere" to culture (trees, shrubs, flowering plants, and turf) (Gan & Xue, 2021; Kolle et al., 2017). Pomology (fruit cultivation), market gardening (vegetable and herb cultivation), and ornamental cultivation (flowers, shrubs, trees) are the main horticulture areas. In turn, ornamental crops have two sub-groups arboriculture (woody plants) and floristry. Nut and grape crops are a small division of horticulture (Arteca, 2015).

Horticultural crops have been grown for millennia in assuring their survival for the future (Goldschmidt, 2013). Human society studied horticulture crops, which conducted many research methodologies to domesticate and introduced horticulture crops for their local areas from other countries (Diamond, 2002; Presniakova et al., 2020). Some tough measures are applied to domesticate and cultivate horticulture crops, e.g., breeding, fertilization, plant protection, irrigation, harvesting (Yang & Xu, 2021). Nowadays, this complexity has been solved based on scientific advanced technologies, as biotechnology, genetics, omics - subjects, and bioinformatics (Arteca, 2015; Chen et al., 2019; Igarashi et al., 2016; Martínez-García et al., 2020; Martínez-Gómez et al., 2021; Velasco et al., 2010; Yu et al., 2020; Zhou et al., 2017).

Horticulture crops have become more domesticated and commonly cultivated in Central Asia (Mirzaev et al., 2004; Tashmatov et al., 2000). The territory of this region occupies approximately four million square kilometers (Lapelia & Programa,

2014). This region is well-known as one of the original centers of horticulture crops, as *Malus domestica*- (apple), *Armeniaca vulgaris* (apricot), *Persica vulgaris* (peach), *Pyrus communis* (pear), *Prunus domestica* (plum), *Vitis vinifera* (grape), *Amygdalus communis* (almond), *Juglans regia* (walnut), *Pistacia vera* (pistachio), *Punica granatum* (pomegranate), and *Ficus carica* (Fig) (Asian Development Bank, 2019; Babu & Djalalov, 2006; Mapelli et al., 2011; Mirzaev et al., 2004; Smale, 2005; Sottile et al., 2014). N.Vavilov in 1930 found some wild apples (*Malus sieversii*) in Central Asia and informed that Central Asia is a center of origin for the domesticated apple (Janick, 2003). Kyrgyzstan, Tajikistan, and Uzbekistan have a large territory of walnut trees, and the region is known as one of the original centers the horticulture crops (Mapelli et al., 2011). For instance, in Kyrgyzstan, walnut forest covers approximately 47 000 hectares, 1.17% percent of the total 4 003 451 km² Central Asian territories (Rehnus et al., 2013). On the other hand, while walnut has occupied a large territory, the coefficient of productivity is in a critical condition (Müller & Sorg, 2001; Scheuber et al., 2000).

During the Soviet Union, Central Asia was a centrally planned economy that cultivated mainly cotton crops (Van Berkum, 2015). The research activity in Central Asia has been organized based on governmental financial support (Babu & Djalalov, 2006; Smale, 2005). For several years, agriculture faced an economic crisis, and this condition sparked in the first period of independence when the gross domestic product (GDP) contributed from agriculture approximately 10-46% (Babu & Djalalov, 2006; Yu et al., 2020). There has been a rapid rise in horticulture trade in Central Asia for the past five years. For instance, in 2018 only, the export of horticulture crops accounted for approximately $108.8 million to Russia, and between 2015 - 2017 exported a total of $1.5 billion fruits to China, Central Asia ($415.5 million) has a significant advantage (World Bank, 2020).

Bibliometric analysis clearly shows the quality and number of scientific articles (Zyoud et al., 2014). Bibliometric analysis includes the number of authors, papers, citations, type of papers, collaboration with international scientists, foundations (inner/outer), institutes/organizations (Zhu & Liu, 2020; Zyoud et al., 2014). A few researchers have addressed the horticulture of Central Asian biodiversity, climate change, walnut forest, Central Asian agriculture trend, export potential of the region, wild relatives of apples, almond, apricot, and their conservation methods, cultivation of seedless grapes, and economic state by a view of World Bank and so on (Asian Development Bank, 2019; Batsaikhan & Dabrowski, 2017; Cantarello et al., 2014; Janick, 2003; Kovalchuk et al., 2017; Lapelia & Programa, 2014; Mamadjanov, 2005; Mirzaev et al., 2004; Rahmani et al., 2015; Rehnus et al., 2013; Romadanova et al., 2016a; Sottile et al., 2014; Van Berkum, 2015; World Bank, 2020; Zaurov et al., 2013). Central Asian horticulture research is currently a less studied topic. This paper reviews a preliminary attempt to estimate bibliometric analysis of Central Asian horticulture (pomology) articles published in Scopus journals in English. We reviewed the number of papers, journals, top authors, institutions, international funds, and researchers who collaborated on the horticulture issue in Central Asia between 2000 and 2020.

2. Materials and Methods

2.1. Selection of subject area

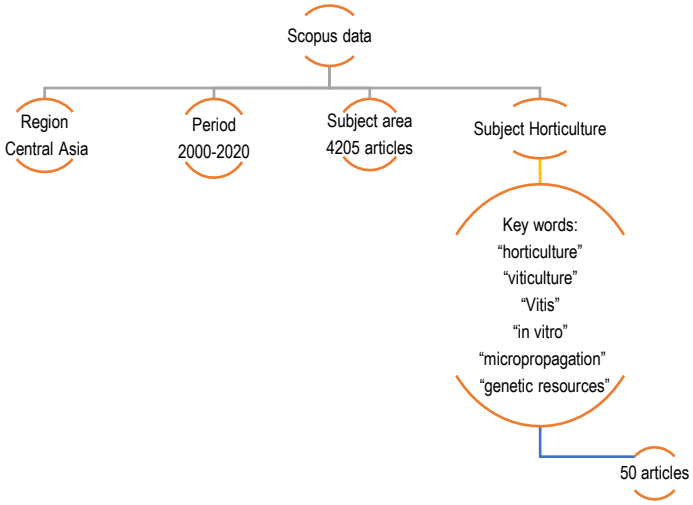

Figure 1. The search strategy of data

To verify the research activities in horticulture in Central Asia, we selected a subject area of Agricultural and Biological Sciences (4205 papers) from the Scopus database between 2000 and 2020. We focused only on pomology (fruit trees) upon reviewing the current state of research activity in Central Asia. All papers were analyzed and reviewed using "horticulture", "viticulture", "Vitis", "in vitro", "micro- propagation", and "genetic resources" as the keywords. 50 Central Asian papers were sorted out for the future analysis of horticulture issues, shown in Figure 1. We used VOSviewer to visualize the bibliometric data, including top authors, keywords used in abstract, and titles (Van Eck & Waltman, 2021).

3. Results and Discussion

3.1. Published papers on horticulture research in Central Asia

We categorized horticulture papers as follows, the paper numbers, authors, and pages per paper between 2000-2020. These analyses revealed the number of papers (NP), authors of papers (AP), the number of authors per paper (NAP), pages of per papers (PP), and the number of references (NR) in the Scopus category of related topic increased gradually. Central Asian researchers were more interested in the horticulture topic, as seen in Table 1. 64 authors published almost 28% of the total number of articles out of 227. The most remarkable finding from the data is that after 2013, the number of publications in the Scopus category journals doubled, and six horticulture papers were published. We observed no articles published on the horticulture issue for the Central Asia region during 2002, 2005, 2007, 2009, 2010, 2012 for the Central Asia region.

Table 1. Characteristics of Central Asian Horticulture articles in the Scopus journals (2000–2020)

	NP	AP	NAP	PP	NR	Year
	1	7	7,0	5	7	2000
	1	1	1,0	14	38	2001
	2	8	4,0	12	24	2003
	1	7	7,0	5	17	2004
	3	10	3,3	27	21	2006
	1	4	4,0	10	19	2009
	2	10	5,0	13	21	2011
	3	17	5,7	27	103	2013
	6	25	4,2	67	196	2014
	3	15	5,0	33	84	2015
	4	20	5,0	34	95	2016
	5	22	4,4	64	171	2017
	2	5	2,5	18	66	2018
	5	25	5,0	48	141	2019
	11	51	4,6	103	225	2020
Total	50	227	4.5	480	1228	

Note. NP- number of papers, AP- authors of papers, NA (AP/NP) – number of authors per paper, PP- page number of per papers, NR- number of references.

3.2. Published articles on horticulture issues in Central Asia between 2000-2020

It is crucial to select the proper journal before submitting the manuscript. Figure 2 shows that before 2014, we found a small number of papers (13 papers), which accounts for nearly 26% of the total 50 articles. In 2014 there was a sharp increase in the number of publications doubled up to 6 articles, whereas before, the rate of the article was three articles per year. The number of publications on horticulture topics fell by 50% in 2015 compared to 2014. The record number of publications among the group was recorded in 2020 (frequency =11).

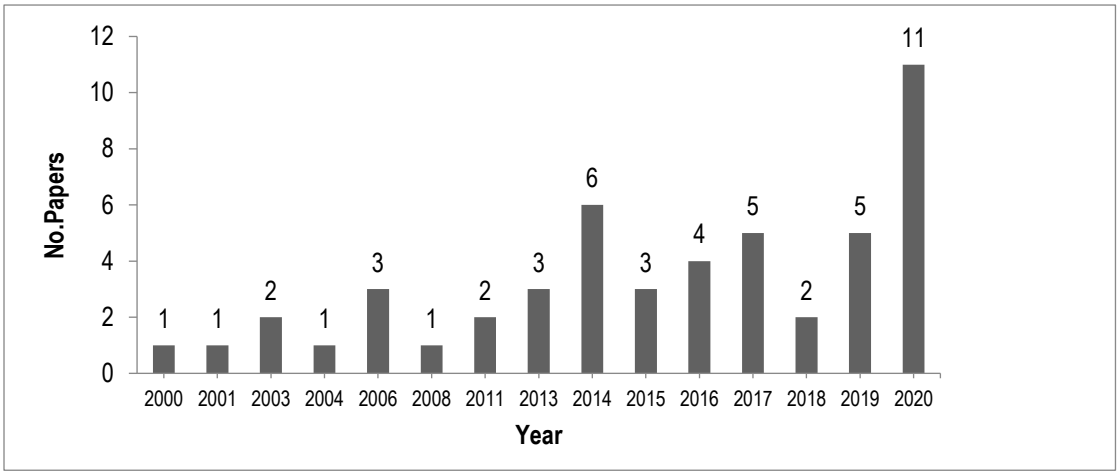

Figure 2. Number of articles with the horticulture topics arranged by the year of publication

Table 2. Journals appearing horticulture research topics between the period 2000–2020.

Journals	Number of papers	Percentage (%)	Journals	Number of papers	Percentage (%)
Acta Horticulturae	8	16	Journal of Applied Botany and Food Quality	1	2
Chemistry of Natural Compounds	5	10	Journal of Elementology	1	2
Cryo-Letters	3	6	Journal of Forestry Research	1	2
Asian Journal of Microbiology,	2	4	Journal Mountain Science	1	2
Eurasian Journal of BioSciences	2	4	Journal of Plant Pathology	1	2
HortScience	2	4	Journal of Sustainable Forestry	1	2
Acta Technologica Agriculturae	1	2	Khimiya Rastitel'nogo Syr'ya	1	2
Agricultural Research Updates	1	2	Plant Biotechnology Reports	1	2
Agrochimica	1	2	Plant Cell, Tissue, and Organ Culture	1	2
Agroforestry Systems	1	2	Plant Methods	1	2
Annals of Agri Bio Research	1	2	PLoS ONE	1	2
Australian Journal of Crop Science	1	2	Research for Rural Development	1	2
Biosciences BR Asia	1	2	Turczaninowia	1	2
Critical Reviews in Food Science and Nutrition	1	2	Valuing Crop Biodiversity: On-Farm Genetic Resources and Economic Change	1	2
European Food Research and Technology	1	2	Food Policy	1	2
Fresenius Environmental Bulletin	1	2	Forests Trees and Livelihoods	1	2
Genetica	1	2	In Vitro Cellular and Developmental Biology - Plan	1	2

Table 2 shows 34 journals that have published Central Asian horticulture research. Almost 28 journals have published at least one article on Central Asian horticultural problems. Some of the major journals were Journal of ActaHorticulturae, Chemistry of Natural Compounds, Asian Journal of Microbiology, EurAsian Journal of BioSciences, HortScience. Figure 3 shows that "ActaHorticulturae" journal published nearly 16% of the papers, followed by the "Chemistry of Natural Compounds" journal, which published five papers (Mamadjanov, 2005; Kovalchuk et al., 2017; Mapelli et al., 2011; Romadanova et al., 2016a; Kovalchuk et al., 2011; Rajametov & Nurbekov, 2020a,b). "HortScience" journal published in horticulture topics from Central Asia, by 4% (2 articles) between 2000 and 2015. The journal "Chemistry of Natural Compounds" actively printed horticulture

articles before 2016; over the last four years, one article has appeared in this Scopus journal. The last three years have witnessed the quality of the horticulture research, and journals like PLoS ONE Plant Method with high CiteScore level published articles from Central Asia (El-Sharkawy et al., 2017; Zhang et al., 2020).

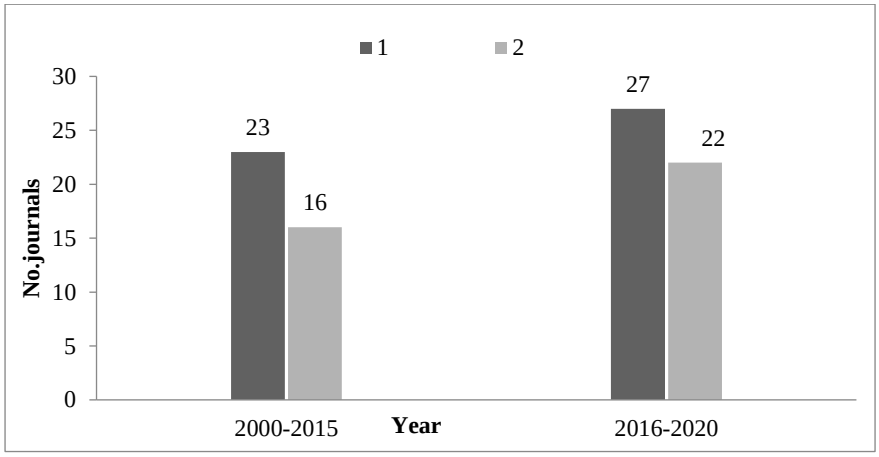

Figure 3. Journals published horticulture topics in 2000-2015 and 2016-2020. Note. 1 = papers, and 2 = journals.

Biotechnology is becoming one of the powerful tools and nuclei of gene editing technologies, and this topic is attractive for scientists (Kovalchuk et al., 2009; Zhou et al., 2017). Figure 4 illustrates 14 most cited papers on horticulture topics. Authors as Kovalchuk, Cantarello, Dalimov have a high level of citation among the group 40, 17, and 14, respectively (Kovalchuk et al., 2009; Cantarello et al., 2014; Dalimov et al., 2003). Kovalchuk I. focused on introducing biotechnology to store apple germplasm and reported that in vitro storage of apple shoots was recommended by several researchers for one or two sorts only. They reported the first application to conserve the large number of apple genotypes by the example of Golden Delicious (Kovalchuk et al., 2009).

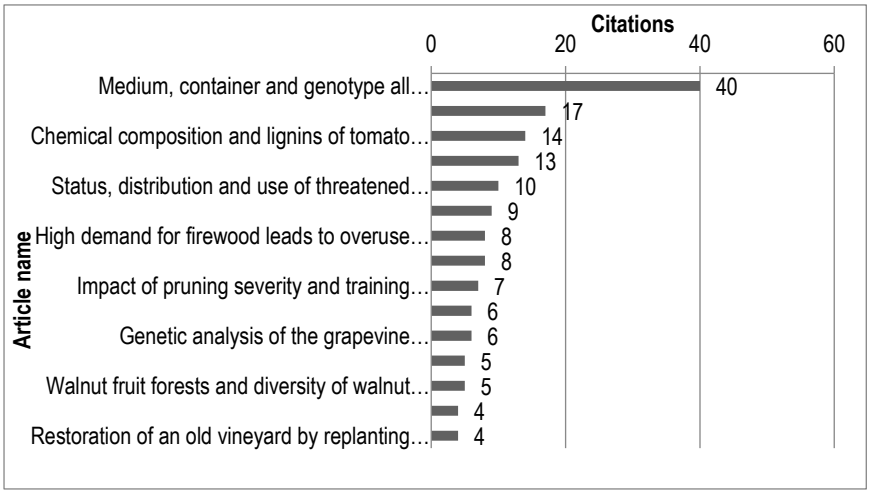

Figure 4. Top cited Central Asian horticulture articles published between 2000 and 2020 year

3.3. Top authors on horticulture in Central Asia

Authors play a critical part in advancing science or developing a specific field. Figure 5 shows the top six writers who have collaborated with Central Asian researchers to study the horticulture issue. There is perfect interaction between authors, and between 2000-2020 total of 227 authors united in publishing 50 papers for horticulture problems in Central Asia. Out of 50 articles, the response rate was 10% for Kovalchuk, as the first author.

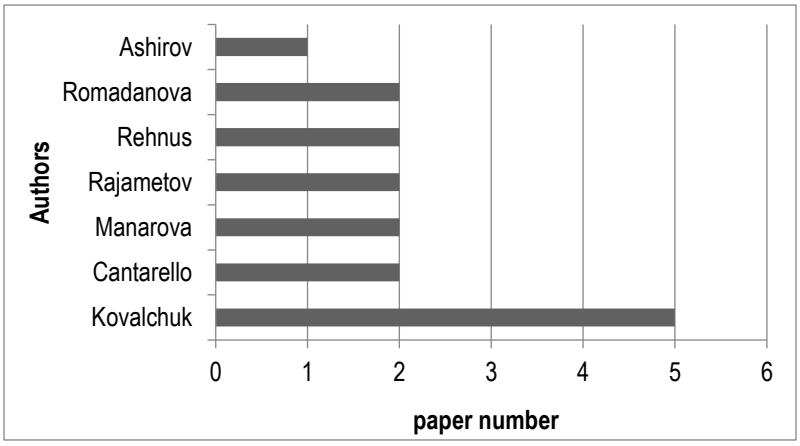

Figure 5. List of top authors published on horticulture issue in Central Asia

Figure 6 demonstrates the overlay visualization of VOSviewer for authors of horticulture topics. Nearly 1.32% of the papers were published by single authors, while the rest part published by two, three, or more than four authors. Three authors (Asilbekova, 2001; Mamadjanov, 2005; Doolotkeldieva, 2018) published their papers as a single author.

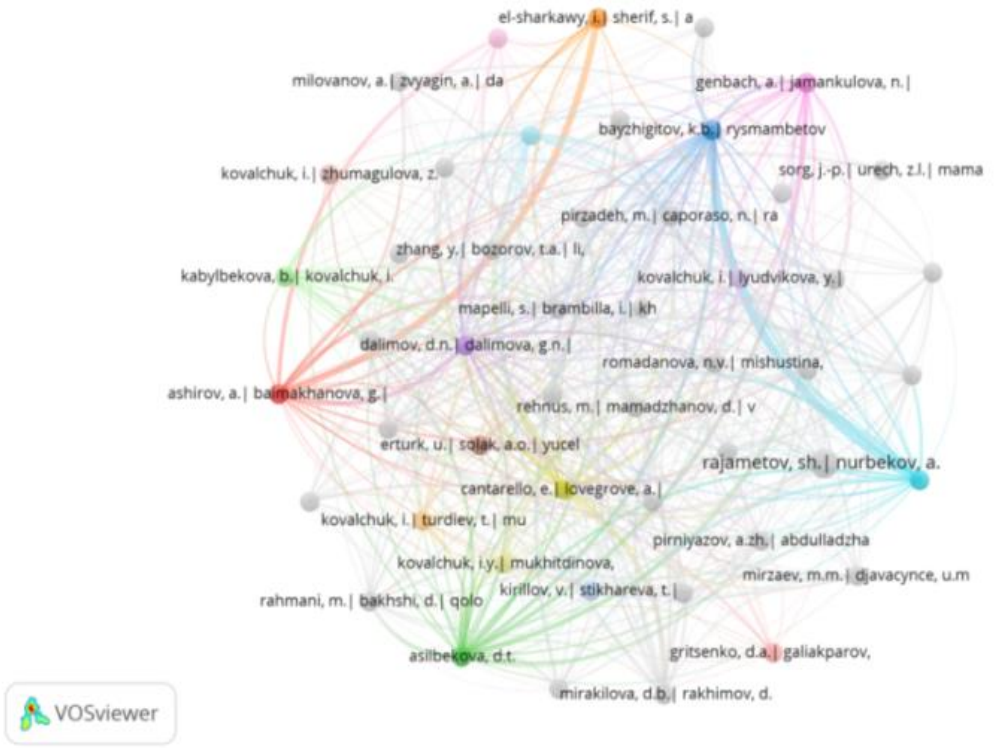

Figure 6: Visualization of authors and co-authors, A total of 50 horticulture articles published in 2000-2020

Figure 7 shows that Reed's cluster is the largest among the group and centralized in the center of visualization of VOSviewer. It informs that Reed collaborated with Central Asian researchers to study horticulture issues. We found that the interaction between authors and participants to study horticulture popularized after 2014 and reached its peak in 2020. A green Kowalchuk's cluster by VOS viewer linked several authors that had relationships with researchers in Central Asia between 2010 and 2014. For instance, Kovalchuk, Nasibulina, and Reed published one article in 2011, in the case of that the color bar of Nasibulina A is green in overlay visualization of VOSviewer. The second cluster of VOSviewer had seven items (authors),

included Kovalchuk, Madiyeva, Mukhitdinova, Reed, Turdieva, and the cluster of Reed owned the highest centrality by the network visualization of VOSviewer.

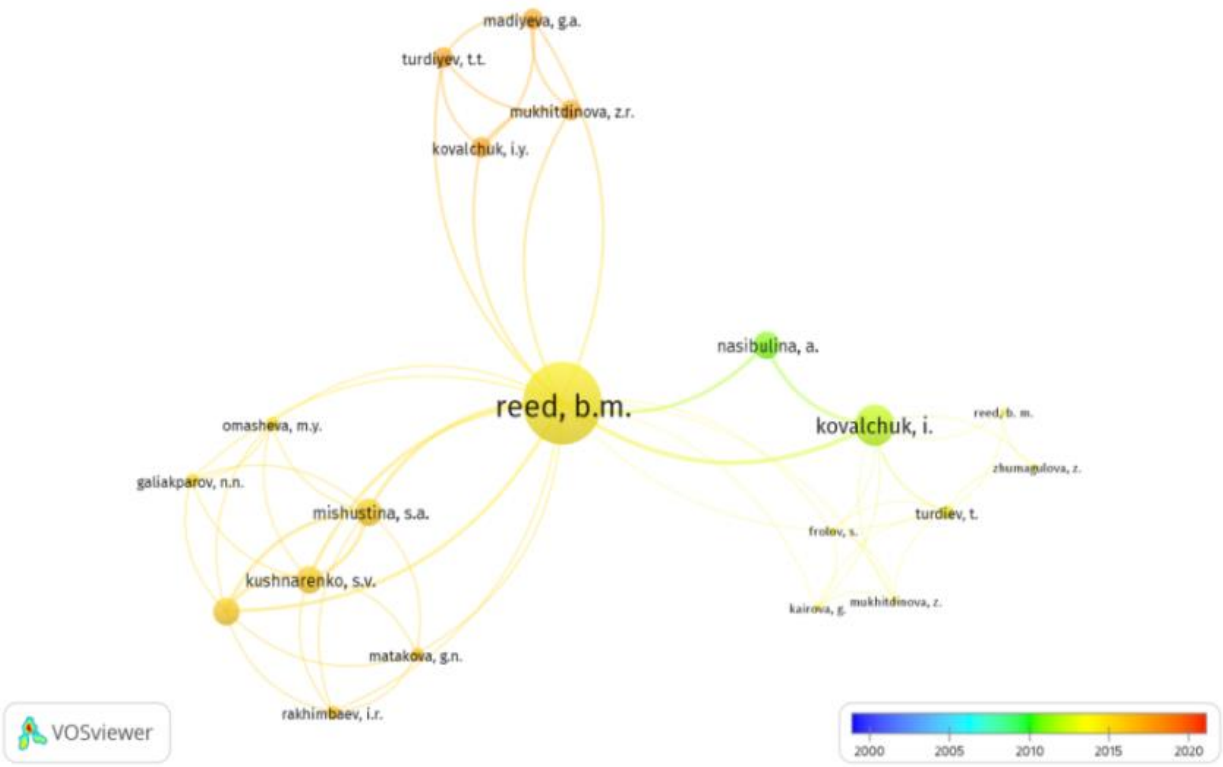

Figure 7. The network visualization of the most horticulture publishers based on the total number of articles. Note: minimum number of documents of an author one was applied for 227 authors. Of the 277 authors, 102 met the threshold, and 20 items connected consisted of 3 items. The link size refers to the total number of articles, while line thickness and color refer to link strength and clustering, respectively.

3.4. Research Institutes studied horticulture issues in Central Asia

Over the past decade, based on the Scopus database, Central Asia collaborated with the UK, Russia, Jordan, Iran, Pakistan, Poland, Turkey, Bulgaria institutions and published several articles in collaboration. 34 research organizations wrote 50 horticulture research papers in Central Asia. Figure 8 shows that the Institute of Plant Biology and Biotechnology (IPBB-Almaty) was the group leader with a significant number of articles. The Institute of PBB collaborated actively with the United States Department of Agriculture (USDA) and published nine articles out of ten with USDA. European Universities interested in studying horticulture in Central Asia and Italian Universities of Palermo, Turin, Naples Federico II, and Pisa contributed actively with A. S. Sadykov Institute of Bioorganic Chemistry (Uzbekistan), University of Semey (Kazakhstan), Tashkent State Agrarian University. Kazakh National Agrarian University published two articles as the single institution of publications about grape cultivars.

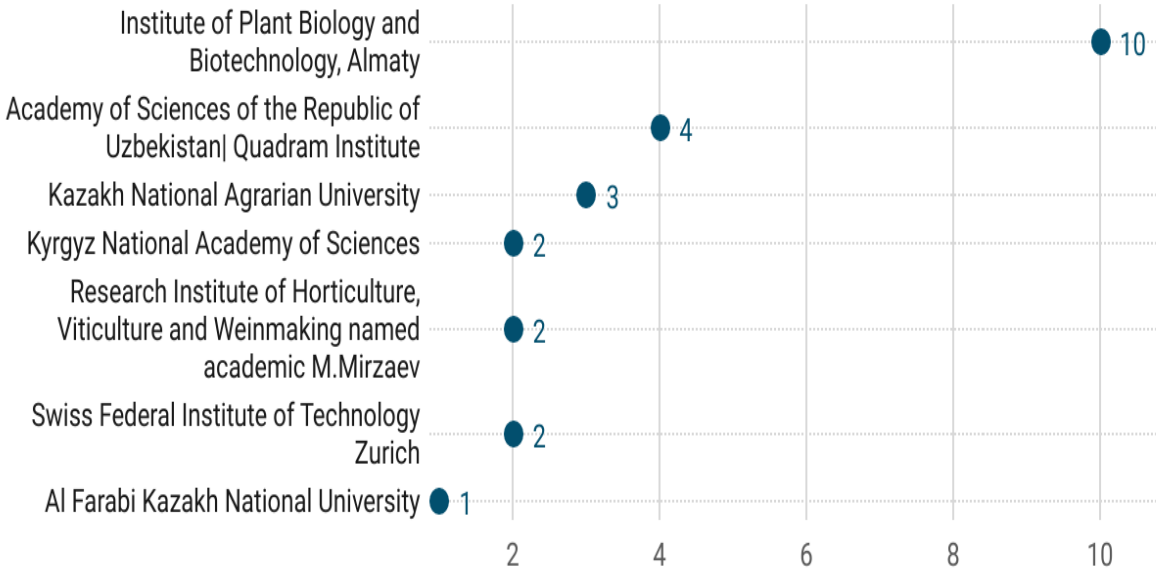

Figure 8. Central Asian organizations published horticulture research from 2000 to the 2020 year

3.5. Funding agencies and countries supported horticulture study in Central Asia

In the database of Scopus, we can see that almost half of the top authors are not from Central Asian countries, but they have jointly published papers in a high-ranked journal. Collaboration with international researchers brought around 33 (66%) papers out of 50 articles. Figure 9 shows that the USA was most collaborated to study horticulture in Central Asia and leader among the group with 13 articles and followed European countries 12 articles, UK 4 articles, Italy and Switzerland by 3 articles, Germany and Finland by 1 article. Between 2000 and 2020, Kazakhstan pioneered with 21 horticulture papers in Central Asia, and 9 of them were in collaboration with the USA, by 1 article with UK, Finland, Germany, and Bulgaria. Uzbekistan has also published 16 articles with countries such as the United States- 10 articles, Italy, Russian Federation- 3 articles, China, the UK, and Kyrgyzstan- 1 article. There are several possible explanations for this situation. One of them is international funding that played a vital role in supporting a study of horticulture in Central Asia.

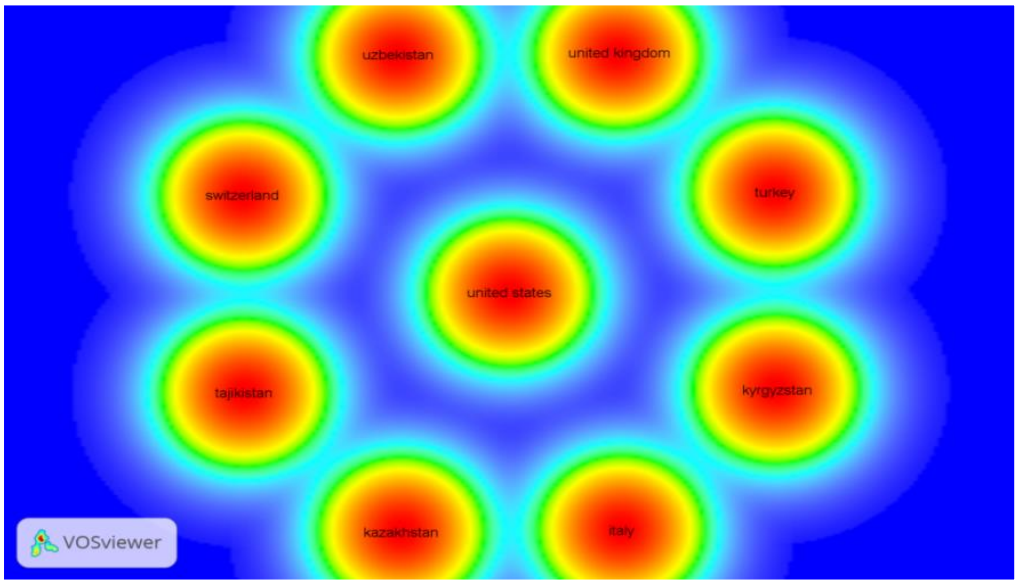

Figure 9. The top countries conducted horticulture research in Central Asia

Table 3. The list of a top international organization funded horticulture study in Central Asia

International Foundations	Authors	Journal	Citations
K428, USDA Agricultural Research Service CRIS 5358-21000-033D project	(Kovalchuk et al., 2017)	Acta Horticulturae	3
	(Kovalchuk et al., 2014)	Cryo-Letters	3
	(Kovalchuk et al., 2009)	Plant Cell, Tissue, and Organ Culture	40
	(Kovalchuk et al., 2011)	Acta Horticulturae	2
Swiss National Science Foundation, the Karl Popper Foundation, and the Vontobel Foundation in the framework of the project "ORECH-LES	(Rehnus et al., 2013)	Journal of Forestry Research	8
	(Van Dusen et al., 2006)	Valuing Crop Biodiversity: On-Farm Genetic Resources and Economic Change	3
	(Rehnus et al., 2013)	Agroforestry Systems	9
	(Sorg et al., 2016)	Journal of Mountain Science	4
UK Darwin Initiative, Conserving Eden: Participatory Forest Management in the Tien Shan Region, 17001	(Cantarello et al., 2014)	Journal of Sustainable Forestry	17
	(Orozumbekov et al., 2015)	Forests Trees and Livelihoods	10
Department of Agriculture Food Environment (DAFE) of the University of Pisa	(Sanmartin et al., 2017)	Agrochimica	4
	(Van Dusen et al., 2006)	Valuing Crop Biodiversity	3

Our investigation shows the importance of interaction in horticulture development in Central Asia. There was a significant positive impact of international funds on horticulture studies in Central Asia. We found values for funding agencies of horticulture study in Central Asia, and the top 6 funding agencies' list is given in Table 3. Further analyses indicated that just under USDA and Agricultural Research Service (ARS) Current Research Information Systems (CRIS), five high-ranked papers were published in a collaboration of nine researchers from several countries. Other five articles were published by supporting Swiss National Science Foundation, the Karl Popper Foundation, and the Vontobel Foundation "ORECH-LES's project. It is essential to highlight that Kazakhstan has worked productively with international funding organizations.

3.6. Keywords Analysis, co-occurrence network

Different keyword clusters are available for the subject areas given in the Scopus database. Our findings would seem to show high-frequency keywords (Figure 10) using VOSviewer. Figure 10(A and B) visualize three clusters of keywords: the first cluster includes four items (words), fatty acid, grape quality, variety, second cluster - germplasm storage, micropropagation, Tajikistan, and the last was apple and walnut. Out of 164 keywords, 13 met the threshold, and the number of occurrences was set to 2 in VOSviewer. Further data collection has mapped on how keywords connect with one other. As seen in Figure 10(A), the distance between the first and third clusters is closer to each other, and visualization illustrates the subject's relation. To investigate the most used keywords, we also mapped using the title and abstract. In Figure 9 (B) states an overlay visualization of horticulture study. From the title and abstract field have been extracted 1477 terms and divided into 11 clusters.

Figure 10(B) states an overlay visualization of the horticulture study. From the title and abstract field have been extracted 1477 terms and divided into 11 clusters. Figure 10(B) illustrates that the keywords fruit (1st cluster includes the large items- 49); leaf, medium, growth, and walnut fruit forest are the most frequent and most discussed by central Asian researchers. The most striking result to emerge from the data is that the research activity of horticulture in Central Asia is beginning to introduce modern methods. It can be seen that the word label of Vitro culture and hepatoprotective activity in overlay visualization disconnected with other labels, and it indicates a new research topic opportunity. In addition, the second cluster, which included forty-seven keywords, lists modern terminology as in micropropagation, Murashige and Skoog medium, in vitro cold storage, molecular SSR, and EST-SSR markers.

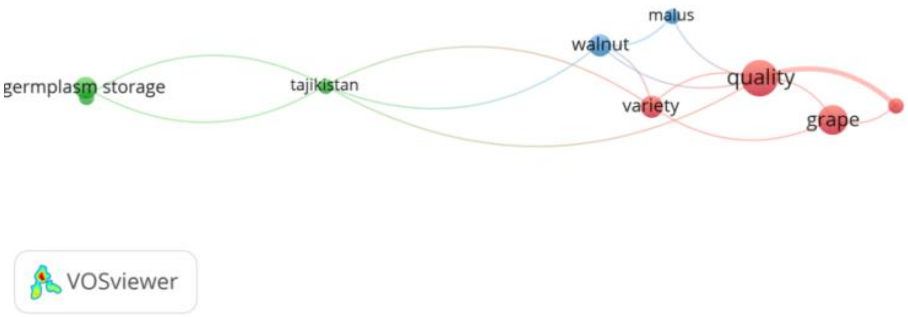

Figure 10(A). Visualization of top terminus used in titles part of 50 papers. A co-occurrence network of keywords frequently appeared in Central Asian horticulture papers. Out of 164 keywords, 13 meet the threshold, and the number of occurrences was set to 2.

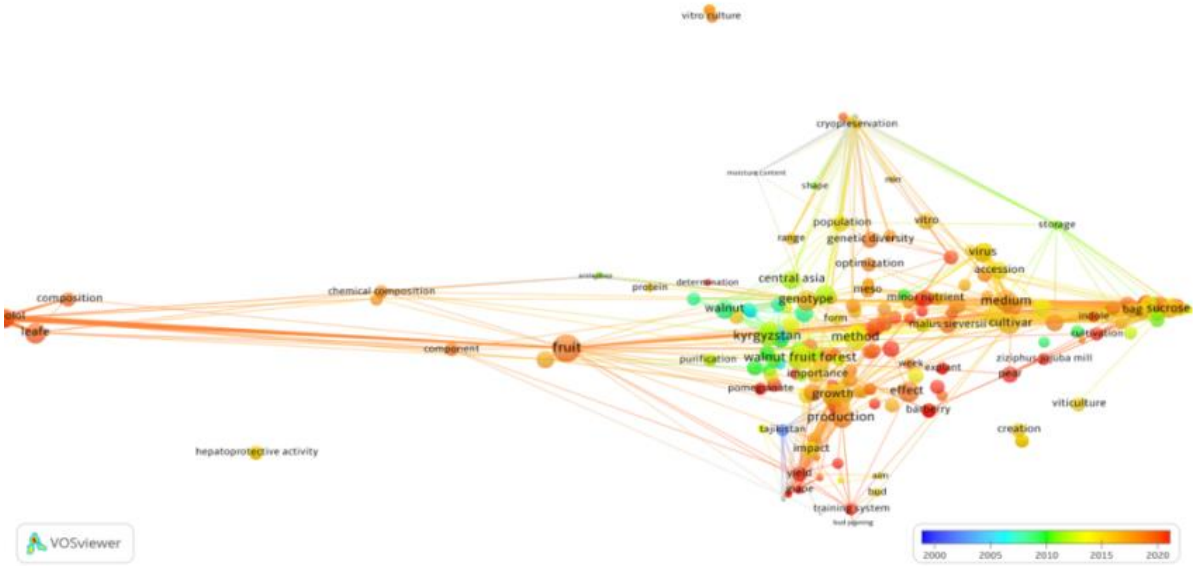

Figure 10(B). Visualization of top terminus used in abstract and title part of 50 papers. Note: term of co-occurrence map constructed based on text data and minimum number of co-occurrence of a term was set to 3, number of term 1477, and 38 of them meet the threshold

Horticulture has a deep background in Central Asia (Mirzaev et al., 2004). This bibliographic analysis of Central Asian horticultural research may not cover and estimate the background and current status of the activity. Figure 11 demonstrates the most studied horticulture crops in Central Asia between 2000-2020. The main reason for this is the region's variety of landscapes and climates (Lapelia & Programa, 2014). Central Asia locates in the heart of the Eurasian landmass, and it possesses unique importance for the plant's biodiversity (Asian Development Bank, 2019). According to some sources, once the Commonwealth of Independent States (CIS) got independence, horticulture crops received less focus than cotton and wheat (Tashmatov et al., 2000). Our downloaded papers inform that CIS made the most outstanding contribution to sustainable use and conservation of flora (Mirzaev et al., 2004; Mamadjanov, 2005; Kovalchuk et al., 2011, Zaurov et al., 2013; Rehnus et al., 2013; Sottile et al.,

2014; Zhang et al., 2020). There are several possible explanations for this result. Central Asia is one of the richest of specific and intraspecific diversity, and some researchers reported a suitable protocol for long-term storage (cryopreservation) (Lapelia & Programa, 2014; Kovalchuk et al., 2009). Further analysis showed that biotechnological methods were applied significantly in horticulture in Central Asia. Walnut (*Juglans regia*) was the most frequent keyword, and the territory of walnut forests covers one-third of Central Asia. For instance, in the south of Kyrgyzstan, walnut covers approximately 631 000, and in Uzbekistan, 4000 hectares. (Mamadjanov, 2005; Mapelli et al., 2011; Rehnus et al., 2013; Cantarello et al., 2014; Orozumbekov et al., 2015; Sorg et al., 2016; Erturk et al., 2019).

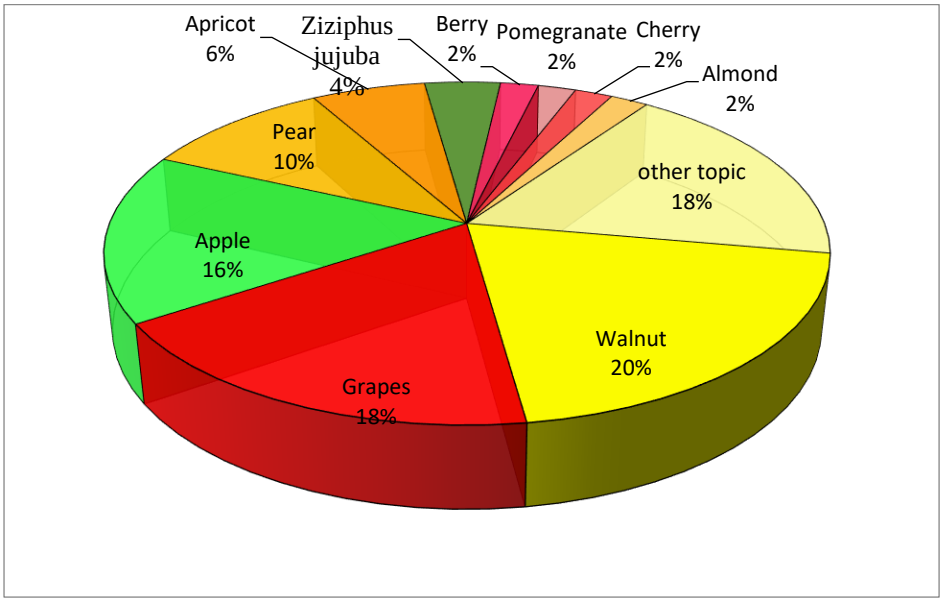

Figure 11. The top horticulture crops conducted to research activity in Central Asia

Grapes (*Vitis vinifera*) are most important and widely cultivated in Central Asia. On average, we found values for the breeding program of grapes, and the number of publications has significantly increased between 2014-2020. Moreover, potential interest increased on study introduced *Vitis* collection within a phenological and alternative genetic method using iBPS markers (Manarova & Kazybaeva, 2015). In addition, Gritsenko and Galiakparov (2017) utilized grapevine virus A (GVA) to design a specific vector. It is worthwhile noting that genetic engineering is applied simultaneously to the horticulture sector in Central Asia (El-Sharkawy et al., 2017). In our view, the identification and characterization of horticulture crops based on genetics lead to a short breeding cycle and sustainable use of biodiversity. In pest management, for instance, this method could be used in plant protection in virus test systems of plants, simplifying the requirements of plant quarantine agencies and increasing export potential (Chen et al., 2019; Gan & Xue, 2021). Kazakhstan has widely applied biotechnology and genetics to the grape industry (Zhambakin & Zhapar, 2020).

Nowadays, the world market of grapes has changed some requirements for exporters, and selflessness is one of the desirable futures for customers (Akkurt et al., 2019). Unfortunately, the scientific result of the breeding program of seedless grapes was reported only in Tajikistan (Rahmani et al., 2015). In recent years breeding program of seedless grapes has been organized by the Center of Genomics and Bioinformatics (Uzbekistan) in collaboration with the National Research Institute Horticulture and Herbal Science (South Korea) (Figure 12). Embryo rescue is a reasonable solution for growing the hybrid population. The embryo rescue method has been applied widely in a breeding program of seedless grapes (Akkurt et al., 2019).

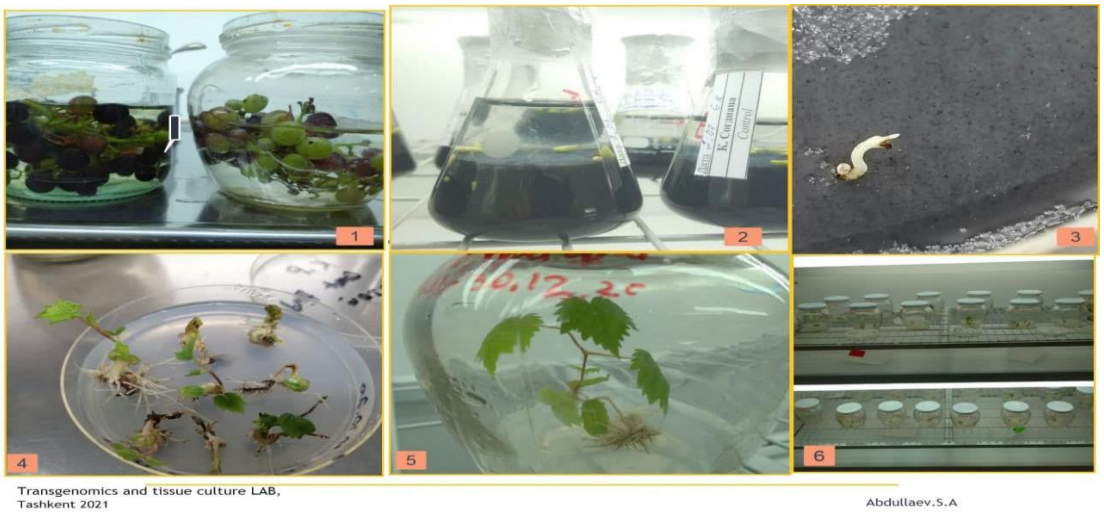

Figure 12. Breeding program of seedless grapes via embryo rescue method

Apple (*Malus domestica* Mil.) is the third frequently studied horticulture crop in Central Asia. One of the most pioneer organizations was the Institute of Plant Biology and Biotechnology-Almaty. They focused on introducing biotechnological and genetical methods to study fruit trees as apples (Romadanova et al., 2016a; Romadanova et al., 2016b; Kabylbekova et al., 2020; Shadmanova et al., 2019), plant protection in Kirgizstan (Doolotkeldieva, 2018), in vitro regeneration system Chinese researchers with Uzbekistan (Zhang et al., 2020) and paper bags to protect apple fruits and using paper bags in protecting apple fruits (Rajametov & Nurbekov, 2020b) in Uzbekistan.

Central Asian countries produced cotton under the name "white gold" over the years (2 million tons), and Uzbekistan accounted for approximately 1.4 million tons (Gerts et al., 2020). Considerable progress has been made concerning the study export potential of agriculture, including the region's horticulture. They conclude that cherry, pears, almonds, pomegranates, apricot cultivars would be a profitable industry for this region (Van Berkum, 2015). According to some reports, the region has 8000 plant species, and 83 of them are apricot varieties, 43 grapes, 40 apples, 30 walnuts, 21 pomegranates, and 15 pears. The crop's wild relives the primary source to develop (disease, stress factor, pest, and virus) resistance verities and conserve food security (Chen et al., 2019; Dempewolf et al., 2017). Over the last years, Central Asian scientists have focused conservation of these crops in genetic banks, and they have developed in vitro and cryopreservation methods (Kovalchuk, et al., 2011; Turdieva et al., 2011). Our findings would seem to show that time-consuming breeding programs were less organized research activity over the studied period (2000-2020).

4. Conclusion

We have presented between 2000 and 2020, a total of 50 horticulture articles have been published in 34 Scopus journals in Central Asia. Horticulture research activity came together with a total of 227 researchers, and the number of researchers has increased significantly from 2011, with an average of 21 authors per year. This work has revealed that the number of publications on the horticulture issue grew significantly from 2014, an average of five articles per year. The list of Scopus category journals increased between 2016 and 2020, about 37% (22) more journals than previous 2015 (16 journals). Out of 50 horticulture articles, 62% (31 articles) have got 189 citations, an average of 6 citations per article. The most productively studied horticulture research in Central Asia was the Institute of Plant Biology, Biotechnology-Almaty (10 articles) and the Academy of Science of Uzbekistan, Quarantine Institute (4 articles). The cooperation of authors illustrates a positive collaboration with international researchers all over the period. VOSviewer centralized Reed's item and the names of Kovalchuk, Frolov, Kairova, Mukhitdinova, Nasibulina, Turdieva, Zhumagulova, connected under Reed's cluster. International funds positively impacted the horticulture issue in the region, and USDA organized three projects to cryopreserve apricot, pear, and apple fruits. Taken together, these international funds might be proved essential in developing horticulture for the enhancement of the conservation of Central Asian horticulture crops. We found that walnut forests were the most studied in Central Asia with an international team. They oriented

to estimate current status and developed some conservation methods of walnut forest in the region. Central Asian researchers applied biotechnology to the propagation and cryopreservation of apple apricot fruits. Finally, this picture f review informs us that the international team upgraded research progress in Central Asia over the past decades.

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