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Constraints on Strawberry (*Fragoria vesca*) Production in Burkina Faso and Benin: A Review

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ABSTRACT

Horticulture represents an important part of the agricultural economy in Burkina and Benin. Strawberry growing is a main activity for many producers. Strawberries are a high value-added product. This analytical review aims to summarize the work carried out on strawberries in order to define research perspectives for a better understanding of the constraints of its production. This review is produced from documentation focused on the relevance of the articles. The identified diseases and pests as the major constraints that can cause losses of up to 100% of production. Burkina is one of the major strawberry producers in West Africa unlike Benin where there are small farms in the North. A research perspective based on major constraints would make it possible to boost strawberry production and ensure better productivity.

Key words: Constraint, *Fragoria vesca*, Market gardening, Production.

In sub-Saharan Africa, the rapid growth of the urban population raises the question of the food supply of cities (Anonymous, 2012). From then on, urban and peri-urban agriculture becomes an option (Abdulkadir *et al.,* 2012) which attempts to respond to the problem of improving food insecurity among city dwellers, due to the weak performance of rural production systems (Anonymous, 2010). Although it is often condemned by the authorities, urban agriculture is a reality in most cities in the South (Mdarhri, 2005). Market gardening is one of the important links in the agricultural sector which can be. Defined as an intensive production activity of vegetables and fruits (FAO, 2012). Indeed, numerous epidemiological studies have shown that a diet rich in fruits is often associated with a low incidence of several chronic pathologies, including obesity, parasitic infections, cardiovascular and neurological diseases and cancer (Allane and Benamara, 2010). The joint report of the World Health Organization and the FAO on the prevention of chronic diseases therefore recommends consumption of at least 400 g of fruits and vegetables per person per day (Anonymous, 2004). In Burkina Faso, market gardening appears today as one of the main components of urban agriculture. Indeed, market garden crops are produced in all regions of Burkina Faso, in urban and peri-urban areas (Adorgloh-Hessou, 2006). It constitutes one of the main agricultural activities which particularly occupy vulnerable sectors of the population (Tokannou and Quenum, 2007). However, market gardening production shows its development hampered by numerous biotic and abiotic constraints which lead, among other things, to a drop in yields and therefore to an irregular and insufficient supply to consumption areas.

Market gardening plays a key role in most nutrition and poverty reduction programs and contributes significantly to family income (James *et al*., 2010 and Yolou *et al*., 2015).

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The fight against food insecurity, poverty and improving the nutritional status of the population requires an increase in the production of fruits and vegetables (Vedukola *et al*., 2019). Strawberry cultivation is one of the most widespread horticultural crops in the world. Strawberries are a fruit consumed either fresh: edible strawberries, or transformed into jam, syrup and beverages or incorporated into other preparations (Keldibekoval and Knyazev, 2023). This analytical review will allow us to know the main constraints linked to strawberry production in Burkina Faso and to provide a summary of the activities carried out strawberries.

Strawberry production worldwide

Strawberries are produced on five continents. Strawberry cultivation is more intensive on the Asian and American continents than on the European and African continents, despite the fact that Europeans are among the largest

consumers of strawberries in the world. In Africa, the consumption of strawberries is until today a luxury in certain West African countries such as Burkina Faso, Senegal, Mali, Ivory Coast even if it is produced locally in small quantities.

The major strawberry producing countries in the world are China with 3.801865 tons; the United States with 1,420,570 tons; Mexico with 468,248 tons. Worldwide 9,125,913 tons of strawberries are produced per year. In Africa, the main strawberry producing countries are: Morocco, Tunisia, Kenya, Burkina Faso and Senegal. Strawberry growing is booming in West Africa with new producing countries such as Mali and the Ivory Coast. Strawberries have seen one of the largest increases in consumption rates of any fruit crop, and demand continues to grow rapidly over the past decade. Yields are linked to the very rich soil, the warm temperature, the health of the plants and technical management. In Benin, strawberries remain exclusively an imported crop. Research, nowadays, is oriented towards the adaptation of strawberries to the edaphic and climatic conditions of agro-ecological zones, the identification of abiotic and biotic constraints, and the creation of varieties that are increasingly productive and resistant to different stresses.

Agromorphological characteristics of strawberries

The strawberry plant (*Fragaria vesca*) of the Rosaceae family produces a fruit from which the receptacle of the flower becomes fleshy after the fertilization of the ovules. The strawberry is a complex fruit (polyakene on a fleshy receptacle). At the base of the strawberry, we can see a floral part (calyx) and the dry stamens of the flower (Photo 1). The strawberry is a perennial herbaceous plants, forming a tuft 5 cm to 40 cm high depending on the species. The plant produces numerous elongated horizontal branches bearing buds, the leaves at the base are trifoliolate, toothed, more or less hairy. Flowers appear naturally in spring. The development, growth and flowering and therefore the fruiting of the strawberry plant depends on environmental factors and photoperiodicity (Table 1). Strawberry plants are classified into four main groups: non-everbearing, semi-everbearing, everbearing and evergreen (Putti, 2005).

For good strawberry production, we need a soil rich in mineral elements (N,P,K,Ca, NaCl, *etc.*). It is important to add compost or manure regularly. Strawberry cultivation is mainly done during the month of October in Africa which corresponds to periods of heat with temperatures varying between 32°C and 37°C. The strawberry plant fears soils that are too clayey, heavy and cold, or too loamy, limestone soils and excess salinity. Strawberries need a pH between 5.5 and 6.5 for optimal production (Putti, 2005).

Nutritional value and importance of strawberries in the human diet

Strawberries fruit has typical flavour and taste that can be eaten raw or cooked (pies, frozen jams, syrup). Strawberry is a low calorie fruit, but rich in fiber, vitamin C, constitutes an important source of antioxidants and stimulates the immune system. The average energy content is 38.6 kcal, 90.3 g water; 0.63 g proteins and 6.03 carbohydrates (Saber *et al*. 2003).

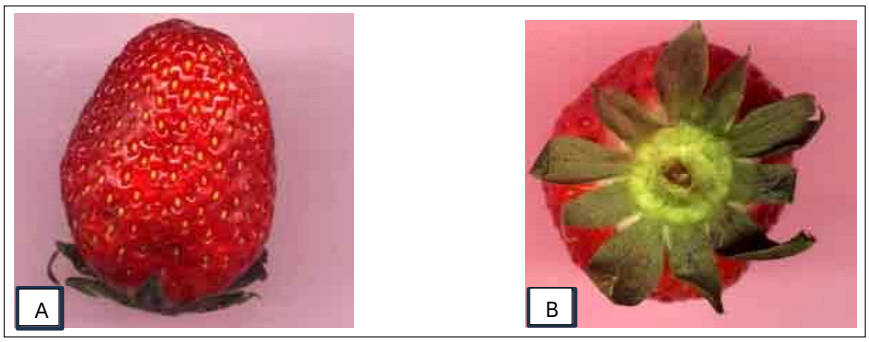

Photo 1: Strawberry fruit (a: profile; b: base). Source: Mouden *et al.* (2013).

Table 1: Condition of the plant according to the season.

Seasons	Summer	Autumn	Winter	Springs
Photoperiod and climate	Long days and high temperature	Decreasing days and decreasing temperatures	Short days and low temperatures	Short (increasing) days and increasing temperatures
Condition of the plants	Plant growth	Slowdown in active growth	Growth stops and goes dormant	Resumption of growth
	Emission of stolons	Floral initiation, beginning of development flower stems, Accumulation of reserves	Breaking of dormancy	Development of flower stems initiated in the fall. Flowering-fruiting. Resumption of floral initiation in certain cases.

Constraints to strawberry production

The strawberry plant is subject to several constraints, phytosanitary constraints, climatic conditions and the inadequacy of storage techniques which favor the incidence of several pathogens responsible for the depreciation of the strawberry. The symptoms are diverse and can be found both on the aerial parts (Photo 2) and on the underground parts. The strawberry is attacked by: strawberry latent angular spot viruses (SLRV) and necrotic shock virus (SNSV), Mites: *Tetranychus urticae*, *Phytoseiulus permilis*. nematodes: *Pratylenchus penetrans* and *Meloidogyne hapla*. Weeds: *Spergula arvensis.*

Several control methods are proposed in order to reduce the losses and improve the production. These includes chemical control, cultural control, biological control, genetic control and the use of plant extracts. But the effectiveness of the good method of struggle requires knowledge of the enemy.

Fungal diseases

Botrytis of strawberries is a fungal disease which causes gray rot of strawberries and caused by *Botrytis cinerea* (Photo 3). Botrytis symptoms are covered with a dense grayish coating which makes the fruit unsuitable for consumption. Factors favorable to the development of botrytis are high humidity and mild temperatures. Botrytis can infect all plant organs, particularly flowers and fruits. The gray rot can cause the significant loss in yield of strawberry.

Anthracnose of strawberries is a disease caused by a fungi, the causative agent is *Colletotrichum fragariae*. Symptoms of anthracnose appear as round lesions measuring 1 to 2 cm on strawberries, with the center of the spot pressed into a “nudge” shape (Photo 4). “Tanned” in color, the necrosis becomes pink then brown. Favorable factors for the development of anthracnose are mild, humid weather and splashing rain. The harm of the disease is significant.

Powdery mildew of strawberries is caused by the fungus *Podosphaera macularis*, formerly *Sphaerotheca humuli*. The symptoms of powdery mildew are characterized by a fine whitish down on the leaflets of strawberries and a reddish color of the lower epidermis. On heavily affected strawberries, powdery mildew attacks the flower stems and even the fruits (Photo 5). Factors favorable to powdery mildew are short periods of humidification (condensation, dew, *etc.*) alternating with periods of sunshine. Powdery mildew is today the most worrying disease, especially above ground in terms of harmfulness.

Phytophthora or strawberry downy mildew, is favored by soil humidity and caused by *Phtophthora fragariae*. Symptoms are observed mainly on the leaves, characterized by browning and drying (Photo 6). The plants become stunted and the fruits appear little or not at all and are inedible.

Purple spot disease, favored by humidity, is a less serious disease that often occurs in the fall. Purple spot disease can be caused by various fungi, the most common of which is *Diplocarpon earlianae* but also *Mycosphaerella fragaria*, *Dendrophoma obscurans* and *Septogioeum fragariae*. The symptoms are characterized by round spots of 3 to 5 mm which appear on the upper surface of the leaves, reminiscent of burns (Photo 7). They are first purple with a lighter center then they turn black-brown before developing. The foliage eventually dries and the plant wilts.

Strawberry pests

The speckled blaniula

It is also called strawberry iule, a speckled centipede (*Blaniulus guttulatus*) with a white body spotted with pink or red on the sides (Photo 8). It feeds on decomposing organic matter but can also attack strawberries.

Strawberry mite

This is a tiny mite (*Tarsonemus pallidus*) transmitted by plants, oval in shape and amber in color which feeds on the leaves of the strawberry plant. The female lays eggs in the heart of the plants in March and the generations continue. The leaves become distorted and stunted, embossed and turn brown. The buds and flowers shrivel and dry out.

Aphids

Like many other plants, strawberries can be infested with aphids. Not very harmful in themselves, aphids can however weaken the plants from which they take the sap to feed and, above all, facilitate the introduction of diseases such as sooty mold, leaf curl or marbling. On strawberries, often encounter green or yellow aphids. Symptoms are characterized by leaves

Photo 2: Leaf lesions and drying out of strawberry plants observed in a strawberry grove in the locality of Moulay Bouselham in Morocco. Source: Mouden *et al.* (2013).

Photo 3: Symptoms of Botrytis rot on strawberry fruit.

Photo 6: Symptoms of late blight on strawberry leaves. Source: Garden Relaxation (2022).

Photo 4: Symptoms of anthracnose on strawberry fruit.

Photo 7: Symptoms of purple spot disease of strawberry leaves.

Photo 5: Symptoms of powdery mildew on strawberry leaves.

Photo 8: Spotted blaniula.

rolling up on themselves and flower buds becoming deformed. A sticky liquid called honeydew settles on the leaves.

The raspberry or strawberry beetle

The raspberry and strawberry beetle (*Anthonomus rubi*) is a black beetle measuring 2 to 4 mm (Photo 9). In May, the female lays eggs in the flower buds of the strawberry plant. Then, the larva, white and without legs, remains for three weeks in this bud or in the fallen buds before pupating. The adult hybernates in the ground or under dead plant matter, and is only active a temperature of 18°C. Symptoms are marked by a flower stalk being bitten, the flower buds drying and falling off.

Slugs

An ambiguous vernacular name designating in French certain gastropods without an external shell belonging to the infraorder. Slugs measure 1 to 30 cm and can weigh 1 to 40 g. Like other Stylommatophora, they have four tentacles, two of which have eyes. They cut the flower bud stalks and attack the fruits.

Birds and rats mainly attack fruits, causing significant damage to strawberry plants

Although Burkina Faso occupies an important rank for strawberry production in West Africa, the fruit is very little known in the country. Little use is made of the product,

Photo 9: Anthonome.

particularly in processing, and few producers cultivate it. Which always makes the fruit expensive and inaccessible for a person with an average income. The kilogram of strawberry fruit is around 3,000 FCFA (4.59 euros) during the availability period between December-March and can reach 5,000 FCFA (5.64 euros) during the lean periodie November and April. Very few scientific studies have been carried out on strawberries (Putti, 2012). This means that we lack data compared to widely consumed market garden crops such as tomatoes and onions.

Several biotic constraints are at the origin of the drop in strawberry productivity. According to Saber *et al*. (2003) *Botrytis cinerea* and *Alternaria alternata* constitute the most dangerous fungal agents on strawberries. *Fusarium semitectum* is a species with a very wide host range, it attacks ornamental plants such as *Hibiscus rosa-sinensis* (Alarcao-E-Silva *et al.,* 2001) and *Pelargonium* sp. It affects different species of banana trees (Pretty *et al.,* 2011, Probst *et al.,* 2012a). This fungus was also isolated from the seeds of *Vigna unguiculata* (Probst *et al.,* 2012b), it is capable of causing damage to young seedlings. It has also been identified as the causative agent of cankers on walnut branches (Williams *et al.,* 2011). Mildew is a mold growing mainly on straw and hay stored in excessive humid conditions. It is often insulated from building materials with moisture problems. Yildirim *et al.* (2001) isolated it from soybean roots where it also appeared pathogenic. Severe infections leading to death of foliage and shoot rot or even mortality of the entire plant have been observed on *Tillandsia tenuifolia*. Anthracnose attacks a wide range of horticultural, cereal or ornamental crops and is present in most cultivated soils around the world (Sharma *et al*., 2023). Investigations carried out in the locality of Moulay Bouselham confirm the attack on strawberry plants by this pathogen at the stem, crown and roots (Sharma and Verma, 2019). The results obtained indicate the presence of a fairly diverse fungal complex comprising species with great antagonistic power, others have pathogenic power on several crops and some are weak parasites. The colonization of the different vegetative organs of strawberry plants by these fungal species can have consequences on their health status, their survival and their yield depending on phytosanitary measures exposed to the reluctance of European markets regarding the use of chemicals. Thus, tracing the evolution of the fungal flora and the comparative examination of plants before and after transplantation could determine the origin of infections occurring on cultivated plants and would allow the adoption of more suitable and timely control methods (Mouden *et al*., 2013).

The strawberry fruit is rich in antioxidants. Antioxidants play an important role in human health (Singh *et al*., 2002). Indeed, it helps reduce cancer, high blood pressure and oxidative stress.

One of the major difficulties in strawberry production is its post-harvest conservation, which lasts no more than 10 days. The genus Mucor has been reported as a post-harvest pathogen of strawberries. These fungi are also found in tomatoes (Pornsuriya *et al*., 2008). Many techniques are proposed but are not suitable or often too expensive for producers and traders. There are several methods of control. Such as the use of bio-pesticides, chemicals, cultural practices and the use of resistant varieties. But market gardeners' current perceptions of aqueous extracts and/or biopesticides have a negative impact on their adoption. The analysis of this impact revealed that it is the perception of aqueous extracts which most negatively affects adoption (Ahn *et al*., 2007, Adékambi *et al*., 2010). This is followed by the perception of the number of treatments required by the use of these aqueous extracts and/or biopesticides. This could be explained by the fact that despite the slowness in their action, these extracts still act very effectively. The promotion of aqueous extracts and biopesticides with a view to increasing their level of adoption undoubtedly requires improving the current knowledge of market gardeners.

CONCLUSION

Market gardening in Burkina and Benin constitutes an essential sector of the economy. It is practiced mainly in the peri-urban and urban areas of large cities. Strawberry cultivation is faced with enormous edaphic, climatic and also biotic constraints. Which prevent certain producers from launching into its production. Market gardeners recognize the profitability aspect of growing the product. These results constitute a exhaustive i.e. detailed research work which will make it possible to develop varieties adapted to environmental conditions with the aim of extending strawberry cultivation throughout the country.

Conflict of Interest

All authors declare that they have no conflict of interest.

REFERENCES

Abdulkadir, A., Dossa, L.H, Lompo, D.J.P, Abdu, N. and Van-Keulen, H. (2012). Characterization of urban and peri-urban agro-ecosystems in three West African cities. International Journal of Agricultural Sustainability. 1-26. doi:10.1080/14735903.2012.663559.

Adékambi, S.A., Adégbola, P.Y. and Arouna, A. (2010). Famers's perception and agricultural technology. The case of botanical extracts and biopesticides in vegetable production in Benin, and 48th Agricultural Economists Association of South Africa (AEASA) Conference, Cape Town, South Africa, September 19-23.

Adorgloh-Hessou, R. (2006). Guide for the development of businesses producing and marketing quality vegetables in the urban and peri-urban regions of South Benin. Consultation report, IITA - Benin, 86p.

Ahn, J., Grun, I.U. and Mustapha, A. (2007). Effects of plant extracts on microbial growth, color change, and lipid oxidation in cooked beef. Food Microbiol. 24: 7–14.

Alarcao-E-Silva, M.L.C.M.M., Leitao, A.E.B. and Azinheira, H.G. (2001). The Arbutus berry: Studies on its color and chemical characteristics at two mature stages. J. Food Compos Anal 14: 27–35.

Allane, T. and Benamara, S. (2010). Antioxydant activities of some common and wild fruits from Algeria. Phytotherapie. 8: 171-175.

Anonymous(2004). Fruit and Vegetables for health. Rep. Jt. FAO/ OMS/OMS.

Anonymous. (2012). FAOSTAT, FAO Statistics Division. URL/faostat. fao.org/consulté le 29 juillet 2012.

Anonymous. (2010). File of the month: The global strawberry market. Export News, Review. Quarterly-Campaign 2010-2011 of the Autonomous Establishment for Export Control and Coordination. 30: 17-20.

FAO. (2012). Growing greener cities in Africa. First status report on urban and peri-urban horticulture in Africa. Roma, FAO. 10 p.

James, B. and al. (2010). Integrated pest management in market gardening: Guide for general introduction for extension agents in West Africa. Ibadan, Nigeria: IITA.

Keldibekova, M.A. and Knyazev, S.D. (2023). Genes and Loci Controlling the Resistance of Strawberry (*F. ananassa* Duch.) to Pathogens. Indian Journal of Agricultural Research. 57(6): 709-716.

Mdarhri, M. (2005). Isolation and identification of the agent responsible for bacterial angular spot disease of strawberry (*Xanthomonas fragariae*). 3rd Cycle Agronomy Thesis, Phytiatry Option, Horticultural Complex, Agronomic and Veterinary Institute Hassan II, Agadir (Morocco), 38 pp.

Mouden, N., Benkirane, R., Ouazzani-Touhami, A. and Douira, A. (2013). Mycoflora of some strawberry varieties (*Fragaria ananassa* L.) cultivated in Morocco. Journal of Applied Biosciences. 4490-4514.

Pornsuriya, C., Lin, F.C, Kanokmedhakul, S. and Soytong, K. (2008). New record of Chaetomium species isolated from soil under pineapple plantation in Thailand. International Journal of Agricultural Technology. 4 (2): 91-103.

Pretty, Toulmin, C. and Williams, S. (2011). Sustainable intensification in African agriculture. International Journal of Agricultural Sustainability. 9(1): 5-24. doi.org/10.3763/ijas.2010.0583.

Probst, L., Adoukonou A., Amankwah, A., Diarra, A., Vogl, C.R. and Hauser, M. (2012b). Understanding change at farm level to facilitate innovation towards sustainable plants protection: a case study at cabbage production sites in urban West Africa. International Journal of Agricultural Sustainability. 1: 1-20. doi.org/10.1080/ijas.14735903.2012.649589.

Probst, L., Houedjofonon, E., Ayerakwa, H.M. and Haas, R. (2012a). Will they buy it? The potential for marketing organic vegetables in the food vending sector to strengthen vegetable safety: a choice experiment study in three west Africa cities. Food Policy. 37(3): 296-308.

Putti, G.L., (2005). Capacité de croissance de la partie aérienne du fraisier (*Fragaria* × *ananassa* Duch) sous conditions naturelles et traitement au froid en automne, et sous longue conservation au froid: évaluation de la respiration et de la chaleur métabolique comme marqueurs de capacité de croissance. Thèse de Doctorat, Université Blaise Pascal, Belgique, 133p.

Sharma, R. and Verma, S. (2019). Environment-Pathogen Interaction in Plant Diseases. Agricultural Reviews. 40(3): 192-199.

Saber, M..M, Sabet, K.K., Moustafa-Mahmoud, S.M. and Khafagi, I.Y.S. (2003). Evaluation of biological products, antioxidants and salts for control of strawberry fruits rots. Egyptian. Journal of Phytopathology. 31(1-2): 31-43.

Sharma1, K., Mirza, A.A., Aarti., (2023). Micronutrient and Metabolic Profiling of Strawberry Cultivars Grown in Subtropical Conditions: A Review. Agricultural Reviews. doi:10.18805/ag.R-2642.

Singh, R.P., Murthy, K.N.C. and Jayaprakacha, G.K. (2002). Studies on the antioxidant activity of pomegranate peel and seed extracts using *in vitro* models. J. Agr. Food Chem. 50: 81–86.

Tokannou, R. and Quenum, R. (2007). Study on the market gardening sub-sector in southern Benin, Final report, AD consult, PAIMAF, 122p.

Vedukola P., Verma S., Sharma D. and Thakur, A. (2019). Role of resistant-proteins in plant innate immunity- A review. Agricultural Reviews. 40(1): 12-20. doi: 10.18805/ag.R-1854.

Williams, S. and Garba, M.H. (2011). Sustainable crop production intensification in the Senegal and Niger river basins of francophone West Africa. International Journal of Agricultural Sustainability.9(1): 171-185. doi.org/10.3763/ijas.2010.0559

Yildirim, A., Mavi, A. and Kara, A. (2001). Determination of antioxidant and antimicrobial activities of *Rumex crispus* L. extracts. J Agr Food Chem 49: 4083-89.

Yolou, F.I. and al. (2015). Market gardening in an urban environment in Parakou in North Benin and its economic profitability. International Journal Innovation Science Research. 19(2): 290-302.