AGRIVITA Journal of Agricultural Science. 2022. 44(3): 595–603

AGRIVITA
Journal of Agricultural Science
www.agrivita.ub.ac.id

Pests and Diseases Management of Konjac (*Amorphophallus muelleri* Blume)

Siti Hardiyanti*), Supriadi, Sri Rahayuningsih and Titiek Yulianti

National Research and Innovation Agency, West Java, Indonesia

ARTICLE INFO

Keywords:
Amorphophallus spp.
Biological control
Integrated Pest Management
Mix cropping
Regulation

Article History:
Received: February 16, 2021
Accepted: September 18, 2022

*) Corresponding author:
E-mail: sitihardiyanti.iaard@gmail.com

ABSTRACT

Amorphophallus oncophyllus Prain ex Hook. f. synonym *A. muelleri* Blume is the main source of glucomannan that is used as a food additive and dietary supplement. The crop has become a favorite in several parts of Indonesia. The plant has been known to have several pests and diseases that can cause significant losses. This review aims to highlight the importance of pests and diseases of konjac and its control strategy. Several pests and diseases attacking the konjac plant have been identified, such as mealybug, scale insect, dry and soft root, collar rot, bacterial blight, leaf spot, and mosaic. The majority of them are seeds or soil born and could be carried from the field to storage. Understanding the causal agents and their ecology is critical in formulating integrated pest management (IPM). Cultivating healthy seeds and mixed cropping with nonhost food crops (maize and rice), or as a second crop under estates' and industrial forests' conditions, as well as biological control, are the most applicable IPM. No specific regulation has been formulated for minimizing pests and diseases of konjac; however, it could adopt general protocol from other crops, such as taro (*Colocasia esculenta*) in India.

INTRODUCTION

Konjac is known to be produced by *Amorphophallus* spp., including *A. konjac*, *A. companulatus* (Roxb.) (locally known "acung"), *A. variabilis* Blume ("suweg"), and *A. oncophyllus* Prain ex Hook. f. synonym *A. muelleri* Blume ("porang") (Jansen, van der Wilk, & Hettersheid, 1996; Supriati, 2016) (Fig. 1). *A. konjac* originates from southern and southeastern China, Vietnam, and possibly Laos. It is widely cultivated in China and Japan and Indochina, the Philippines, and Hawaii (Jansen, van der Wilk, & Hettersheid, 1996). Although *A. muelleri* is found in several places in Indonesia, the plant is occasionally cultivated only in Java (Jansen, van der Wilk, & Hettersheid, 1996). Indonesian konjac is generally exported to Japan with the volume of 1,000 tons per year (Afifah, Oktorina, & Setiono, 2014).

Nowadays, konjac is widely cultivated in Madiun, Ngawi, and Nganjuk East Java, Indonesia. In 2019, the planting area was recorded at 1602 hectares and yielded 9128 tons of tubers and 1553 tons of chips. Konjac's average productivity was 5.6 tons per hectare (Kuncoro, 2020). The Indonesian Government plans to increase the konjac cultivation areas in West Java, Central Java, East Java, Banten, East Nusa Tenggara, and South Sulawesi, up to 17,886 hectares in 2020. Meanwhile, the South Sulawesi government has started a 10 hectares cultivation pilot project and enlarged up to 564 hectares (Direktorat Jenderal Tanaman Pangan, 2020). Growing konjac is economical and could earn a net income of IDR 62,905,000/ha, with a B/C ratio of 1.818 (Mutmaidah & Rozi, 2015). Konjac is wildly or limitedly cultivated under forest shade trees to optimize forest land (Rokhmah & Supriadi, 2015).

Konjac flour is extracted from the plant's tuber or corm. It can be processed into noodles (Faridah & Widjanarko, 2014), bread (Laignier et al., 2022), and jam (Ardiansyah, Hintono, & Pratama, 2019). Konjac is also used in the pharmaceutical industry as a nutraceutical for diabetes (Ariftiyana et al., 2022) and stroke (Alamsyah, 2019). Purified konjac flour, konjac glucomannan, is used as a food additive and dietary supplement in many Asian and European countries (Behera & Ray, 2017). In

ISSN: 0126-0537 Accredited First Grade by Ministry of Research, Technology and Higher Education of The Republic of Indonesia, Decree No: 30/E/KPT/2018

Cite this as: Hardiyanti, S., Supriadi., Rahayuningsih, S., & Yulianti, T. (2022). Pests and diseases management of konjac (*Amorphophallus muelleri* Blume). *AGRIVITA Journal of Agricultural Science*, *44*(3), 595–603. http://doi.org/10.17503/agrivita.v44i3.2938

addition, glucomannan gel is used as food, drug carrier, tissue scaffold, absorption material, and sensing material (Yang et al., 2017).

Indonesia's konjac market is estimated to absorb around 50 thousand tons of fresh tubers; if the plant's productivity is 4 t/ha, then the planting area to meet this supply is 12,000 ha (Santosa, 2014). From the cultivation aspect, the availability of seeds and land is a critical factor in increasing konjac production, so it needs policy support from Government for land provision (Santosa, 2014). The majority (84.8%) of lowland agricultural land ownership in East Java, West Java, West Sumatra, and South Sulawesi is controlled by almost half of the land households (49.0%) of around 0.5 hectares per family. In contrast, for upland land, 83.2% of agricultural land is controlled by 27.4% of households with an area of more than 0.5 ha (Yusdja, 1984). Therefore, farmers prioritize the use of their agricultural land to grow food crops for their daily needs. Thus, the opportunity for farmers to plant konjac on the available land area is limited. Therefore, the chance to expand konjac plantations can only be done on industrial plantation forest land. Santosa (2014) showed that the Government owns industrial forest areas that were used as konjac planting areas could benefit farmers' income by around US$ 3.000 for every 2-3 ha. This cultivating system is also helpful for preventing illegal logging and forest encroachment (Santosa, 2014).

MATERIALS AND METHODS

The review analyzed published literature on the cultivation and pest management of konjac in Indonesia and abroad from 1996 to 2021. The first book of konjac was published in the Plant Resources of South-East Asia 9 "Plants Yielding Non-Seed Carbohydrates" edited by M. Flach, & F. Rumawas (Backhuys Publisher). Since then, many publications are electronically available in local and international scientific journals. Pests and diseases of konjac are intensively studied in China.

DISCUSSION

Pests and Diseases of Konjac

Information on the pests and diseases of Indonesian konjac is limited. Still, in other countries, such as China, India, and Japan, few pests and diseases of *Amorphophallus* spp. have been reported to cause significant losses (Table 1). Amongst pests, mealybug (*Rhizoecus amorphophalli* (Hemiptera: Pseudococcidae), *a* scale insect of *Aspidiella hartii* (Hemiptera: Diapididae), and root-knot (*Meloidogyne incognita* and *M. javanica*) (Ray, 2015; Reddy, 2015) are found in the field and could be carried in the harvested tubers to the storage and could interfere plant growth and reduce yield loss. Other pests reported are *Galerucida bicolor* (Coleoptera: Chrysomelidae), *Araecerus fasciculatus* (Coleoptera: Anthribidae), caterpillars, and nematodes (Jansen, van der Wilk, & Hettersheid, 1996).

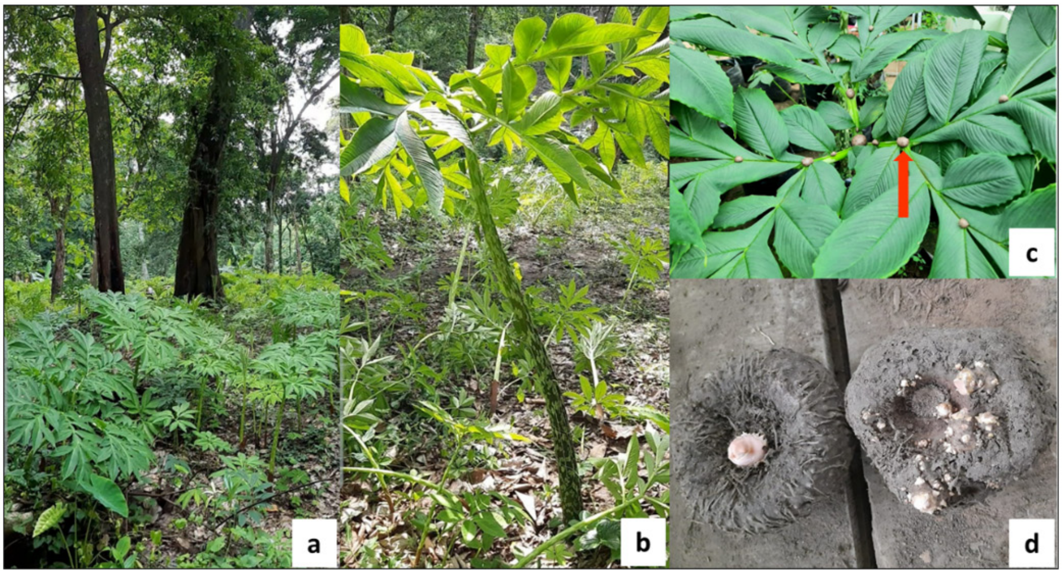

Fig. 1. Konjac cultivation on the multi-cropping system (a); konjac plant (b); bulbil type of konjac for propagation (c); and konjac tubers (d) (Source: Ika Roostika Tambunanan).

In contrast, diseases of konjac are mainly affected tubers and cause rotting that could affect plant growth and yield losses. Important diseases are caused by fungi, such as *Fusarium solani*, *F. oxysporum*, *Botrytis cinerea, Pythium helicoides,* and *Sclerotium rolfsii* (Lui & Kushalappa, 2002; Roy & Hong, 2008; Tajuddin, Santosa, Sopandie & Lontoh, 2020; Wu et al., 2020; Yu et al. 2015). Several bacterial diseases are identified, such as *Pectobacterium carotovorum* subsp. *carotovorum, P. chrysanthemi*, and *Pseudomonas pseudoalcaligenens* subsp. conjact (Wu, Diao, Gu, & Hu, 2010). Another disease is Dasheen Mosaic Virus (Babu, Hegde, Makeshkumar, & Jeeva, 2011). Amongst the diseases, soft rot caused by *Pectobacterium carotovorum* subsp. *carotovorum* and *P. chrysanthemi* is the most destructive (Wu, Diao, Gu, & Hu, 2010) (Fig. 2; Table 2).

The majority of konjac pests and diseases are seed-borne; which means tuber planting materials can carry them to new areas. Insect pests, such as *A. hartii* and pathogens (*Fusarium* sp.*, Pythium* sp.*,* and *Sclerotium* sp.) have broad host plants. *A. hartii* infection on yam tuber could reach up to 20%. The female is often concealed in crevices and partially hidden underplant or soil (Salerno et al., 2018). Plant disease, *Fusarium* spp. are soil-borne pathogens and have many host plants, and survive as resistant spores free in the ground for a very long period. *Phytium* zoospores swim in the water in search of host tissues. *B. cinerea* can be carried out from the field and remains latent in the storage. It develops well during higher relative humidity and low temperature storage. The temperature range is 20-30°C. The fungus survives long in the sclerotia forms in the dead infected host tissues or tuber seeds (Romanazzi & Feliziani, 2014). The sclerotia and mycelium of *B.cinerea* could survive on plant debris, weeds, or soil surface (Elad, Williamson, Tudzynski, & Delen, 2007). The sclerotia of *S. rolfsii* could be spread through tools used in field works and water splashing (Punja, 1985). Dasheen Mosaic Virus has many host plants, including Araceae and ornamental (Nelson, 2008), transmitted by aphids or plant sap through mechanical injuries and vegetative propagation (Gollifer, Jackson, Dabek, Plumb, & May, 1977; Nelson, 2008). The pathogen has many plant hosts (Malvaceae, Cruciferae, Brassicaceae, Solanaceae, Cucurbitaceae, Apiaceae, Fabaceae, Chenopodiaceae, and Leguminosae) (Anwar, Zia, Hussain, & Kamran, 2007) and weeds worldwide (Rich, Brito, Kaur & Ferrell, 2009).

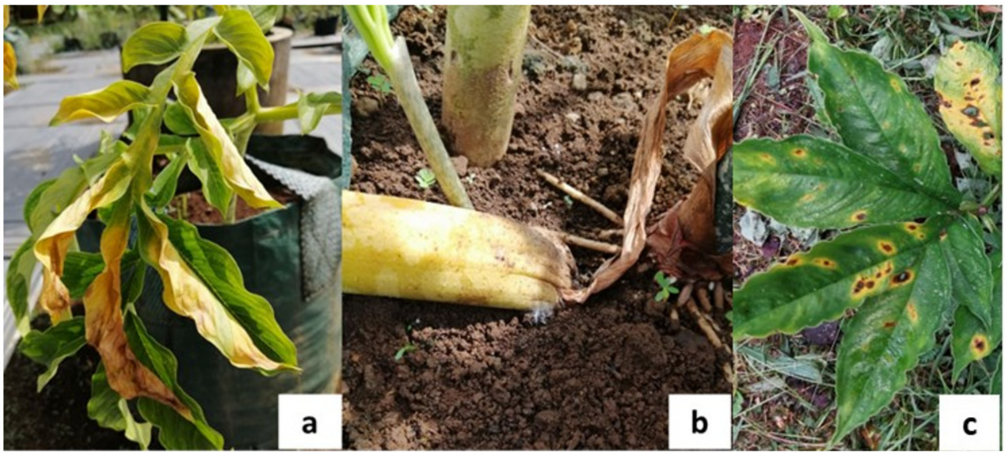

Fig. 2. Diseases on the konjac plant: leaf blight (a); stem rot caused by soil-borne disease (b); and leaf spot (c)

Table 1. Yield losses due to pest and disease of konjac

Pest and Disease	Yield Losses (%)	Reference
Leaf blight	88	Soedarjo & Djufry (2021)
Viral disease	87	Soedarjo & Djufry (2021)
Dry rot	20-30	Wu, Zhou, Jiao, Fu, & Guo (2019)
Soft rot	30-50	Jiang et al. (2021)
Whiteflies	87	Soedarjo (2020)

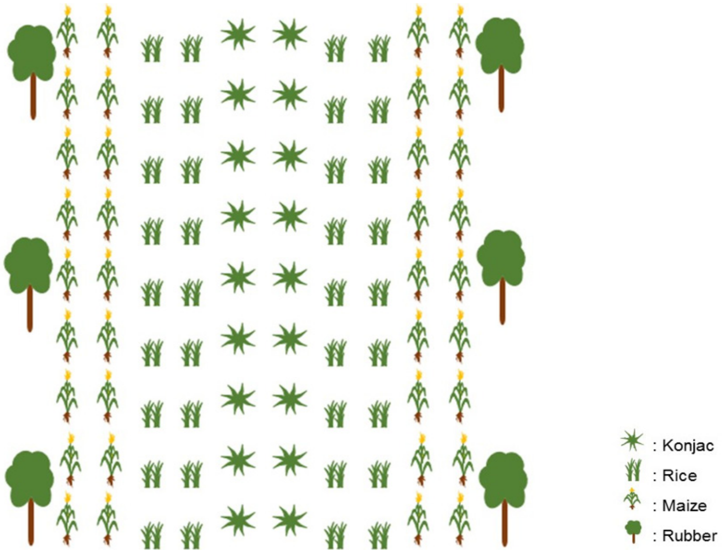

Fig. 3. Cropping system of konjac-rice-maize on a young rubber plantation.

Table 2. Important pests and diseases of konjac

Name	Causal agent	Occurrence	Losses	Reference
Pests				
Mealybug	*Rhizoecus amorphophalli*	Field and storage	Delay sprouting and growing; reduce yield and quality	Reddy (2015)
Scale Insect	*Aspidiella hartii*	Field and storage	Reduce yield and quality	Ray (2015)
Root-knot	*Meloidogyne incognita* and *M. javanica*.	Field and storage	Plant growth and yield loss	Brito et al. (2010)
Diseases				
Dry tuber rot	*Fusarium solani*, *Fusarium oxysporum*, and *Botrytis cinerea*	Field and storage	Reduce yield and quality (aflatoxin)	Lui & Kushalappa (2002) Yu et al. (2015)
Soft rot	*Pectobacterium carotovorum* subsp. *carotovorum* and *Pectobacterium chrysanthemi*.	Field and storage	Plant death	Wu, Diao, Gu, & Hu (2010)
Root rot	*Pythium helicoides*	Field and storage	Plant growth and tuber rot	Roy & Hong (2008)
Collar rot	*Sclerotium rolfsii*t	Field and storage	Plant growth and tuber rot	Pravi, Jeeva, & Archana (2014)
Leaf blight	*Pseudomonas pseudoalcaligenens* subsp.conjaci	Field	Plant growth	Goto (1983)
Anthracnose	*Colletotrichum siamense*	Field	Plant growth	Wu et al. (2020)
Mosaic	Dasheen Mosaic Virus	Field and storage	Plant growth and tuber loss	Babu, Hegde, Makeshkumar, & Jeeva (2011)

Control Strategy of Konjac Pest and Disease

Seed Treatment

As the pests and diseases of konjac are carried out by propagating seed tubers; therefore, seed treatment is critical. Seed treatment is an application of pesticides to seeds before planting to reduce the source inoculum of pests and pathogens. The tuber seeds of konjac should be disinfected with 72% streptomycin (1g/l), fludioxonil, and boscalid for 3 minutes (Yu et al., 2015). Soaking tubers before planting using hot water at 55°C for 10 minutes reduces mosaic disease incidence and increases tuber production (Reddy, 2015). Imidacloprid and thiamethoxam have been used for seed treatment and significantly affected on cumulative germination rate (Huang et al., 2015).

Mix Cropping with Non-Hosted Plants

The cultivation of konjac in mixed cropping systems with corn for 1-3 years altered the soil bacterial community structure and composition, which led to a relative balance of beneficial bacteria (Wu et al., 2018). The relative proportion of beneficial bacteria helps reduce the incidence of soft rot (*Pectobacterium* spp.). Konjac could be intercropped with maize and rice under young rubber plants for up to two-year-old, in a standard single-row spacing of rubber of 6-7 m x 3 m (or 475-550 trees/ha), which has a light intensity of around 55% (Sahuri, 2019) (Fig. 3).

After maize and rice crops are harvested, the straw is left as mulch to increase beneficial soil microbes colonizing konjac rooting systems further to reduce plant pathogenic microbial population in the soil and increase crop yields. Rice straw is high in silica, a nutrient element involved in plants' major roles (Van Soest, 2006). Rice straw application was correlated to soil/water-extractable carbon content that can induce the microbial community (Pan, Li, Chapman, & Yao, 2016). The relative proportion of beneficial bacteria helps reduce the incidence of soft rot (*Pectobacterium* spp.). Continuously cultivated konjac for three consecutive years is not recommended because of the risk of building up soil-borne pathogens (Wu et al., 2017). Besides, composted agro-waste plant products could also be amended into the soil to inhibit soil-borne pathogens, such as *M. incognita* (Pandey & Kalra, 2010). Balanced N and K fertilizers can suppress plant disease development; however, excessive N fertilizer is not recommended (Sudir, Nuryanto & Kadir, 2015). Increasing soil temperature by polyethylene mulching sheet for two weeks in hot summer effectively reduces soil population densities of sclerotia of *S. rolfsii* and controls pathogen infection (Yaqub & Shahzad, 2009).

With the available information on the crucial pests and diseases and lessons learned in controlling them, it seems that pest and disease studies are required for sustainable konjac production. Adopting a suitable mix cropping system of konjac with other nonhost food crops, estate crops, and medicinal crops is essential. A mixed cropping system is critical for small-scale farmers since they can rely on the cropped plant's yield before the konjac.

Physical and Mechanical Controls

Removing and burying diseased and damaged crops needs to be adopted as a regular practice since these could become a source of a new infection. Therefore, the practices could prevent their spread in the field. Plant debris removal could be done while fielding activities for manuring, weeding, and inspection that is made 60 and 90 days after planting and before harvesting or at the appropriate growth stage depending on the crop condition (Trivedi & Gunasekaran, 2013). After harvest, this practice must be continued while inspecting for the presence of storage pests and diseases.

Biological Control

Biological control using *Trichoderma harzianum* combined with manure could reduce disease incidence caused by S. rolfsii by 85.33%. The effectiveness of *T. harzianum* is associated with various enzymes, such as peroxidase, polyphenol oxidase, phenylalanine ammonia-lyase, chitinase, and glucanase (Kamel, Farag, Arafa, & Essa, 2020). The scale insect of *Aspidiella hartii* has several insect parasitoids, such as *Physcus comperi*, *Adelencyrtus moderatus*, *Coccobius (Physua) comperi*, and *Adelencyrtus moderatus* that can infect the pest in field and storage (Reddy, 2015). More research is needed to evaluate the potential of biological control agents in minimizing the scale insect on konjac.

Regulation

There is no regulation formulated for konjac production. Therefore, it can follow that proposed for taro (*Colocasia esculenta*) as described by Trivedi & Gunasekaran (2013). Aspects need to be regulated including land preparation, corm seeds production, pest and diseases control, postharvest, and certification. The land used for cultivation must be free from volunteer plants and plant residues from the previous crop and has good drainage. Planting materials must be true-types, uniform or max 5% in size variations, and free from fungi, bacteria, viruses, and scale insects that can damage the plant. In the field, disease symptoms must be free or max 1% for dasheen mosaic virus's incidence. Harvested corm seeds must be minimized from damages, such as cut, bruised, cracked, and damaged by insects (other than scale insects and mealybugs), slugs, or worms. Field inspections for pests and disease monitoring need to be regularly checked or at least two times after planting and before harvest.

Chemical Control

No registered chemical pesticides are available for controlling pests and diseases of konjac. However, several studies revealed that sodium salt solution effectively controls mealybugs and maintains tuber quality (Nedunchezhiyan, Jata, Ray, & Misra, 2011). Spraying mancozeb (0.2%) or metalaxyl (0.05%) fungicide can control *A. paeoniifolius* leaf spot (Reddy, 2015). Fludioxonil or thiabendazole fungicides effectively control dry rot tubers of Fusarium (Gachango, Hanson, Rojas, Hao, & Kirk, 2012). β-aminobutyric acid treatment (100 mmol/l) on tubers can induce resistance against dry rot of *F. sulphureum* (Yin et al., 2010). The crude extract of Bacillus subtilis can inhibit *Erwinia carotovora* subsp. carotovora (Deng et al., 2011). Dipping tubers in strong lime+ sulfur solution (1:10 in water) could reduce the scale insect of *A. hartii* (Salerno et al., 2018).

CONCLUSION

Some pests and diseases are serious problems in the cultivation of konjac. They can reduce the yields and the quality of tuber seeds. Pests and diseases management is required, through cultural methods, biological, and chemical approaches.

ACKNOWLEDGEMENT

The authors are very grateful to Dr. Ika Roostika Tambunan who has permitted the use of the konjac photos collection for publication.

REFERENCES

Afifah, E., Oktorina, M., & Setiono. (2014). Peluang budidaya iles-iles (*Amorphophallus* spp.) sebagai tanaman sela di perkebunan karet. *Warta Perkaretan*, *33*(1), 35-46. https://doi.org/10.22302/ppk.wp.v33i1.48

Alamsyah, M. A. B. O. (2019). Pengaruh glukomanan terhadap penurunan risiko penyakit stroke iskemik. *Jurnal Ilmiah Kesehatan Sandi Husada*, *10*(2), 292–298. Retrieved from https://akper-sandikarsa.e-journal.id/JIKSH/article/view/171

Anwar, S. A., Zia, A., Hussain, M., & Kamran, M. (2007). Host suitability of selected plants to *Meloidogyne incognita* in the Punjab, Pakistan. *International Journal of Nematology*, *17*(2), 144-150. Retrieved from https://bit.ly/3ycTiNX

Ardiansyah, G., Hintono, A., & Pratama, Y. (2019). Karakteristik fisik selai wortel (*Daucus carota* L.) dengan penambahan tepung porang (*Amorphophallus oncophyllus*) sebagai bahan pengental. *Jurnal Teknologi Pangan*, *3*(2), 175–180. Retrieved from https://ejournal3.undip.ac.id/index.php/tekpangan/article/view/23520

Ariftiyana, S., Nurfikasari, L., Murniyati, D., Prastowo, A., Kurniasari, Y., Hadi, H., & Aprilia, V. (2022). Porang (*Amorphophallus oncophyllus*) flour macerated with strobilanthes crispus reduced the blood glucose levels of streptozotocin-induced diabetic rats. *Open Access Macedonian Journal of Medical Sciences*, *10*(T8), 127–131. https://doi.org/10.3889/oamjms.2022.9505

Babu, B., Hegde, V., Makeshkumar, T., & Jeeva, M. L. (2011). Molecular detection and identification of *Dasheen mosaic virus* infecting *Amorphophallus paeoniifolius*. *Archives of Phytopathology and Plant Protection*, *44*(13), 1248–1260. https://doi.org/10.1080/03235408.2010.490398

Behera, S. S., & Ray, R. C. (2017). Nutritional and potential health benefits of konjac glucomannan, a promising polysaccharide of elephant foot yam, *Amorphophallus konjac* K. Koch: A review. *Food Reviews International*, *33*(1), 22–43. https://doi.org/10.1080/87559129.2015.1137310

Brito, J. A., Kaur, R., Cetintas, R., Stanley, J. D., Mendes, M. L., Powers, T. O., & Dickson, D. W. (2010). *Meloidogyne* spp. infecting ornamental plants in Florida. *Nematropica*, *40*(1), 87–104. https://experts.nebraska.edu/en/publications/meloidogyne-spp-infecting-ornamental-plants-in-florida

Deng, Y., Zhu, Y., Wang, P., Zhu, L., Zheng, J., Li, R., … Sun, M. (2011). Complete genome sequence of *Bacillus subtilis* BSn5, an endophytic bacterium of *Amorphophallus konjac* with antimicrobial activity for the plant pathogen *Erwinia carotovora* subsp. *carotovora*. *Journal of Bacteriology*, *193*(8), 2070–2071. https://doi.org/10.1128/JB.00129-11

Direktorat Jenderal Tanaman Pangan. (2020). Menteri pertanian (mentan) syahrul yasin limpo (syl) terus meningkatkan budidaya porang. Retrieved from https://tanamanpangan.pertanian.go.id/detil-konten/berita/237

Elad, Y., Williamson, B., Tudzynski, P., & Delen, N. (2007). Botrytis: Biology, pathology and control. Dordrecht: Springer. https://doi.org/10.1007/978-1-4020-2626-3

Faridah, A., & Widjanarko, S., B. (2014). Penambahan tepung porang pada pembuatan mi dengan substitusi tepung mocaf (Modified cassava flour). *Jurnal Teknologi dan Industri Pangan*, *25*(1), 98–105. https://doi.org/10.6066/jtip.2014.25.1.98

Gachango, E., Hanson, L. E., Rojas, A., Hao, J. J., & Kirk, W. W. (2012). *Fusarium* spp. causing dry rot of seed potato tubers in Michigan and their sensitivity to fungicides. *Plant Disease*, *96*(12), 1767–1774. https://doi.org/10.1094/PDIS-11-11-0932-RE

Gollifer, D. E., Jackson, G. V. H., Dabek, A. J., Plumb, R. T., & May, Y. Y. (1977). The occurrence and transmission of viruses of edible aroids in the Solomon Islands and the Southwest Pacific. *Pans*, *23*(2), 171–177. https://doi.org/10.1080/09670877709412425

Goto, M. (1983). *Pseudomonas pseudoalcaligenes* subsp. *konjaci* subsp. nov., the causal agent of bacterial leaf blight of konjac (*Amorphophalus konjac* Koch.). *International Journal of Systematic and Evolutionary Microbiology*, *33*(3), 539–545. https://doi.org/10.1099/00207713-33-3-539

Huang, L., Zhao, C.-L., Huang, F., Bai, R.-E., Lü, Y.-B., Yan, F.-M., & Hao, Z.-P. (2015). Effects of imidacloprid and thiamethoxam as seed treatments on the early seedling characteristics and aphid-resistance of oilseed rape. *Journal of Integrative Agriculture*, *14*(12), 2581-2589. https://doi.org/10.1016/S2095-3119(15)61140-6

Jansen, P. C. M., van der Wilk, C., & Hettersheid, W. L. A. (1996). Amorphophallus Blume ex Decaisne. In M. Flach, & F. Rumawas (Eds.), *Plant Resources of South-East Asia 9: Plants Yielding Non-Seed Carbohydrates* (pp. 45-50). Leiden: Backhuys Publishers. Retrieved from https://research.wur.nl/en/publications/amorphophallus-blume-ex-decaisne

Jiang, X., Wang, Z., Yang, F., Chen, Z., Yang, S., Yan, Z., & Qin, Y. (2021). Effects of different pesticide treatments on soft rot control and yield of konjac. *IOP Conference Series: Earth and Environmental Science*, *687*, 012049. https://doi.org/10.1088/1755-1315/687/1/012049

Kamel, S., Farag, F., Arafa, R., & Essa, T. (2020). Bio-control potentials of *Trichoderma* spp. against *Sclerotium rolfsii* the causative of root and crown rot in tomato, common bean and cabbage. *Egyptian Journal of Phytopathology*, *48*(1), 122–136. Retrieved from https://bit.ly/3CuiZMJ

Kuncoro, E. (2020). Pelepasan “varietas” tanaman porang untuk mendorong penyediaan benih dan program pengembangan tanaman porang secara luas. Retrieved from http://bbppmbtph.tanamanpangan.pertanian.go.id/index.php/berita/383

Laignier, F., de Cássia de Almeida Akutsu, R., de Lima, B. R., Zandonadi, R. P., Raposo, A., Saraiva, A., & Botelho, R. B. A. (2022). *Amorphophallus konjac*: Sensory profile of this novel alternative flour on gluten-free bread. *Foods*, *11*(10), 1379. https://doi.org/10.3390/foods11101379

Lui, L. H., & Kushalappa, A. C. (2002). Response surface models to predict potato tuber infection by *Fusarium sambucinum* from duration of wetness and temperature, and dry rot lesion expansion from storage time and temperature. *International Journal of Food Microbiology*, *76*(1–2), 19–25. https://doi.org/10.1016/S0168-1605(01)00752-8

Mutmaidah, S., & Rozi, F. (2015). Peluang peningkatan pendapatan masyarakat tepi hutan melalui usahatani porang. Paper presented at *Prosiding Seminar Hasil Penelitian Tanaman Aneka Kacang dan Umbi 2015* (pp. 709-716). Malang: Balai Penelitian Tanaman Aneka Kacang dan Umbi. Retrieved from http://docplayer.info/47113718-Peluang-peningkatan-pendapatan-masyarakat-tepi-hutan-melalui-usahatani-porang.html

Nedunchezhiyan, M., Jata, S. K., Ray, R. C., & Misra, R. S. (2011). Management of mealybug (*Rhizoecus amorphophalli*) in elephant foot yam (*Amorphophallus paeoniifolius*). *Experimental Agriculture*, *47*(4), 717–728. https://doi.org/10.1017/S0014479711000500

Nelson, S. C. (2008). Dasheen Mosaic of edible and ornamental aroids. *Plant Disease*, *44*, 1–9. Retrieved from https://www.ctahr.hawaii.edu/oc/freepubs/pdf/PD-44.pdf

Pan, F., Li, Y., Chapman, S. J., & Yao, H. (2016). Effect of rice straw application on microbial community and activity in paddy soil under different water status. *Environmental Science and Pollution Research*, *23*(6), 5941–5948. https://doi.org/10.1007/s11356-015-5832-5

Pandey, R., & Kalra, A. (2010). Inhibitory effects of vermicompost produced from agro-waste of medical and aromatic plants on egg hatching in *Meloidogyne incognita* (Kofoid and White) Chitwood. *Current Science*. *98*(6), 833-835. Retrieved from https://www.jstor.org/stable/24109854

Pravi, V., Jeeva, M. L., & Archana, P. V. (2014). Rapid and sensitive detection of *Sclerotium rolfsii* associated with collar rot disease of *Amorphophallus paeoniifolius* by species-specific polymerase chain reaction assay. *Molecular Biotechnology*, *56*(9), 787–794. https://doi.org/10.1007/s12033-014-9757-x

Punja, Z. K. (1985). The biology, ecology, and control of *Sclerotium rolfsii*. *Annual Review of Phytopathology*, *23*(1), 97–127. https://doi.org/10.1146/annurev.py.23.090185.000525

Ray, R. C. (2015). Post harvest handling, processing and value addition of elephant foot yam — An overview. *International Journal of Innovative Horticulture, 4*(1), 1-10. Retrieved from https://www.indianjournals.com/ijor.aspx?target=ijor:ijih&volume=4&issue=1&article=001

Reddy, P. P. (2015). Plant protection in tropical root and tuber crops. New Delhi: Springer. https://doi.org/10.1007/978-81-322-2389-4

Rich, J. R., Brito, J. A., Kaur, R., & Ferrell, J. A. (2009). Weed species as hosts of *Meloidogyne*: A review. *Nematropica*, *39*(2), 157-185. Retrieved from https://journals.flvc.org/nematropica/article/view/64478

Rokhmah, D. N., & Supriadi, H. (2015). Prospek pengembangan iles-iles (*Amorphophallus muelleri* Blume) sebagai upaya diversifikasi pangan di Indonesia. *Sirinov*, *3*(1), 1–10. Retrieved from https://perpus.univpancasila.ac.id/repository/web.pdf

Romanazzi, G., & Feliziani, E. (2014). *Botrytis cinerea* (Gray Mold). In S. Bautista-Baños (Ed.), *Postharvest Decay: Control Strategies* (pp. 131-146). Academic Press. https://doi.org/10.1016/B978-0-12-411552-1.00004-1

Roy, S. G., & Hong, C. X. (2008). The first finding of pythium root rot and leaf blight of elephant foot yam (*Amorphophallus paeonifolius*) in India. *Plant Pathology, 57*(2), 369. https://doi.org/10.1111/j.1365-3059.2007.01627_57_2.x

Sahuri. (2019). Teknologi tumpangsari karet - tanaman pangan: kendala dan peluang pengembangan berkelanjutan. *Jurnal Penelitian dan Pengembangan Pertanian*, *38*(1), 23-34. https://doi.org/10.21082/jp3.v38n1.2019.p23-34

Salerno, M., Mazzeo, G., Suma, P., Russo, A., Diana, L., Pellizzari, G., & Porcelli, F. (2018). *Aspidiella hartii* (Cockerell 1895) (Hemiptera: Diaspididae) on yam (*Dioscorea* spp.) tubers: a new pest regularly entering the European part of the EPPO region. *EPPO Bulletin*, *48*(2), 287–292. https://doi.org/10.1111/epp.12480

Santosa, E. (2014). Pengembangan tanaman iles-iles tumpangsari untuk kesejahteraan petani dan kemandirian industri pangan nasional. *Jurnal Risalah Kebijakan Pertanian Dan Lingkungan: Rumusan Kajian Strategis Bidang Pertanian Dan Lingkungan*, *1*(2), 73-79. Retrieved from https://jesl.journal.ipb.ac.id/index.php/jkebijakan/article/view/10288

Soedarjo, M. (2020). The field observed insects would challenge the expansion of porang (*Amorphophallus muellery* Blume) cultivation in Indonesia. *International Journal of Research Studies in Agricultural Sciences*, *6*(12), 40–52. https://doi.org/10.20431/2454-6224.0612005

Soedarjo, M., & Djufry, F. (2021). Identified diseases would threaten the expansion of *Amorphophallus muellery* Blume cultivation in Indonesia. *IOP Conference Series: Earth and Environmental Science*, *648*, 012043. https://doi.org/10.1088/1755-1315/648/1/012043

Sudir, Nuryanto, B., & Kadir, T. S. (2015). Epidemiologi, patotipe, dan strategi pengendalian penyakit hawar daun bakteri pada tanaman padi. *Iptek Tanaman Pangan*, *7*(2), 79-87. Retrieved from http://repository.pertanian.go.id/handle/123456789/4322

Supriati, Y. (2016). Keanekaragaman iles-iles (*Amorphophallus* spp.) dan potensinya untuk industri pangan fungsional, kosmetik, dan bioetanol. *Jurnal Penelitian Dan Pengembangan Pertanian*, *35*(2), 69-80. https://doi.org/10.21082/jp3.v35n2.2016.p69-80

Tajuddin, M., Santosa, E., Sopandie, D., & Lontoh, A. P. (2020). Characteristics of growth, flowering and corm yield of iles-iles (*Amorphophallus muelleri*) genotypes at third growing period. *Biodiversitas*, *21*(2), 570–577. https://doi.org/10.13057/biodiv/d210219

Trivedi, R. K., & Gunasekaran, M. (2013). *Indian minimum seed certification standards*. New Delhi: The Central Seed Certification Board Department of Agriculture & Co-operation Ministry of Agriculture Government of India. Retrieved from https://bit.ly/3SzJ6Yc

Van Soest, P. J. (2006). Rice straw, the role of silica and treatments to improve quality. *Animal Feed Science and Technology*, *130* (3–4), 137–171. https://doi.org/10.1016/j.anifeedsci.2006.01.023

Wu, J. P., Zhou, J., Jiao, Z. B., Fu, J. P., Xiao, Y., & Guo, F. L. (2020). *Amorphophallus konjac* anthracnose caused by *Colletotrichum siamense* in China. *Journal of Applied Microbiology*, *128*(1), 225–231. https://doi.org/10.1111/jam.14460

Wu, J., Diao, Y., Gu, Y., & Hu, Z. (2010). Infection pathways of soft rot pathogens on *Amorphophallus konjac*. *African Journal of Microbiology Research, 4*(14), 1495–1498. Retrieved from https://academicjournals.org/journal/AJMR/article-full-text-pdf/787BCB413872

Wu, J., Jiao, Z., Guo, F., Zhou, J., Qiu, Z., & Ding, Z. (2017). Effects of cultivation duration and mode on the microbial diversity of the Amorphophallus konjac rhizosphere. *African Journal of Agricultural Research*, *12*(23), 1970-1979. https://doi.org/10.5897/AJAR2017.12304

Wu, J., Jiao, Z., Zhou, J., Zhang, W., Xu, S., & Guo, F. (2018). Effects of Intercropping on rhizosphere soil bacterial communities in *Amorphophallus konjac*. *Open Journal of Soil Science*, *8*(9), 225–239. https://doi.org/10.4236/ojss.2018.89018

Wu, J., Zhou, J., Jiao, Z., Fu, J. & Guo, F. (2019). Identification of the pathogens causing konjac dry rot in China. *Journal of Plant Diseases and Protection, 126*, 263-264. https://doi.org/10.1007/s41348-019-00211-1

Yang, D., Yuan, Y., Wang, L., Wang, X., Mu, R., Pang, J., … Zheng, Y. (2017). A review on konjac glucomannan gels: Microstructure and application. *International Journal of Molecular Sciences*, *18*(11), 2250. https://doi.org/10.3390/ijms18112250

Yaqub, F., & Shahzad, S. (2009). Effect of solar heating by polyethylene mulching on sclerotial viability and pathogenicity of *Sclerotium rolfsii* on mungbean and sunflower. *Pakistan Journal of Botany*, *41*(6), 3199–3205. Retrieved from http://mail.pakbs.org/pjbot/PDFs/41(6)/PJB41(6)3199.pdf

Yin, Y., Li, Y.-C., Bi, Y., Chen, S.-J., Li, Y.-C., Yuan, L., … Wang, D. (2010). Postharvest treatment with β-aminobutyric acid induces resistance against dry rot caused by *Fusarium sulphureum* in potato tuber. *Agricultural Sciences in China*, *9*(9), 1372–1380. https://doi.org/10.1016/S1671-2927(09)60228-5

Yu, L., Zhao, J., Liu, J., Wu, X., Wang, D., Xu, S., & Srzednicki., G. S. (2015). Identification of postharvest pathogens of *Amorphophallus muelleri* and indoor screening of fungicides. *Journal of Agricultural Science and Technology A*, *5*(7), 577–584. https://doi.org/10.17265/2161-6256/2015.07.002

Yusdja, Y. (1984). Pemilikan dan pengusahaan lahan pertanian di pedesaan Indonesia. *Forum Penelitian Agro Ekonomi*, *3*(2), 5-11. https://doi.org/10.21082/fae.v3n2.1984.5-11