東北大学機関リポジトリ
TOUR
Tohoku University Repository

Research core of biological-production ecosystems in the fields of forests, grasslands and volcanic ash soils

著者	Nanzyo Masami
journal or publication title	Journal of Integrated Field Science
volume	1
page range	7-15
year	2004-03
URL	http://hdl.handle.net/10097/30917

Research core of biological-production ecosystems in the fields of forests, grasslands and volcanic ash soils.

Masami Nanzyo

Graduate School of Agricultural Science, Tohoku University
1-1 Tsutsumidori-Amamiyamachi, Aobaku, Sendai, 981-8555, Japan

Key words : forest ecology, volcanic ash soil, biological production

Introduction

There are many volcanoes in Japan, especially in Hokkaido, Tohoku, Kanto, Chuubu and Kyuushuu districts. Volcanic ash soils showing distinctive properties are widely distributed around and eastern side of the volcanoes. The volcanic ash soils cover 16% of Japanese lands. Natural and agricultural ecosystems with high biological activities and productivities are formed on these volcanic ash soils. These soils and ecosystems serve as a water reservoir due to their highly porous properties and gradually provide abundant water and inorganic nutrients such as silicon and basic cations to the downstream ecosystems. Comprehensive research and education works are carrying on regarding the biological-production and ecosystems in the area of forests, grasslands and volcanic ash soils.

Forest ecology

A variety of seed-size and phenology among and within species contribute to maintain succession and diversity of species in the deciduous broad-leaved forests in the temperate regions (Seiwa, 1998; 1999a,b; 2000; Kanno et al., 2001; Saitoh et al., 2002; Nagamatsu et al., 2002; Tomita et al., 2002). Figure 1 shows acorn dispersal by *Apodemus argentius*. Although many acorns germinate near their parent trees, most of them die due to species-specific diseases. Seedlings established far from their parent trees can grow, leading to species diversity in the forest (Seiwa et al., 2002a; 2002b). It was also found out that the riverside tree species, *Salix sachalinensis* and *Juglans ilanthifolia*, have a special reproduction strategy (Ueno and Seiwa, 2003; Kimura et al., 2004). Further, using DNA sequencing, AFLP and SSR analysis, ecological studies on the molecular basis are in progress covering phylogenetic relationships among species of forest plants, and gene flow and clonal structures at the community level (Suyama et al., 2000a, b; Obayashi et al., 2002; Iwamoto et al., 2002; Tsumura et al., 2000). Figure 2 shows an example of the parent and children relationship found using the DNA analysis. The white dots show the position of mature trees in the natural beech forest in the square of 150m by 150m. The seedlings locate within 20 m from their parents whereas pollens come from farther places.

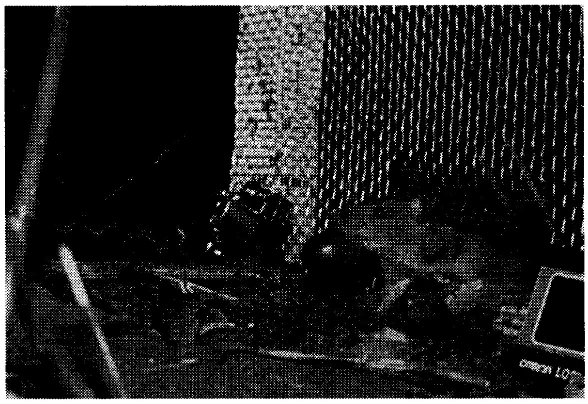

Figure 1. Acorn dispersal by *Apodemus argentius*. Many acorns germinate near their parent trees, but most of them die due to species-specific diseases. Seedlings established far from their parent trees can grow, leading to species-diversity in the forest.

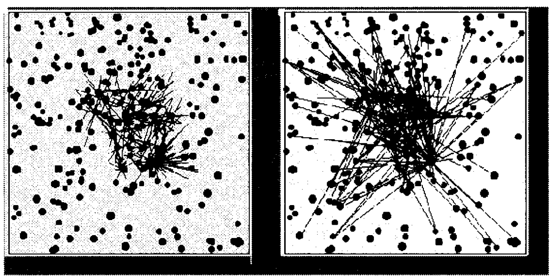

Figure 2. Seed and pollen dispersal patterns revealed by DNA analysis. Positions of mature trees in the natural beech forest of 150mx150m(●), and their seed and pollen dispersal patterns. DNA analysis was done using 253 mature trees and 1258 seedlings.

Genesis, properties and classification of volcanic ash soils

Major parent material of the volcanic ash soils are tephras (Figure 3), including some other aolian additives to various extents. Tephras are provided to the ecosystems by huge eruption of volcanoes with different dormant periods or intermittent small-scale eruptions of active volcanoes. Strong westery and river water play an important role to disperse tephras in the wide areas. Rock types of volcanic ash, which affect the properties and productivities of volcanic ash soils, are defined with SiO_2 content of the fresh ash (Shoji et al., 1975a; Kobayashi et al., 1976). Rock type of the matured volcanic ash soils can also be estimated using V/Zn content of ferromagnetic minerals that are resistant to weathering (Shoji et al., 1975b). A major component of fresh volcanic ash is volcanic glass and it rapidly weathers under humid climate and good drainage releasing large amount of Si, Ca, Na and so on. Aluminum is residually concentrated as allophane, imogolite, Al-humus complex and halloysite, and iron, ferrihydrite and other iron minerals in the volcanic ash soils. Most of these are poorly crystalline and they give distinctive chemical (high humus accumulation, variable charge, high P sorption, and so on) and physical (low bulk density, high water retention and high water permeability, high aggregate stability, high liquid and plastic limits, irreversible changes with drying, and so on) properties to the volcanic ash soils.

High P sorption is one of the chemical indices characterizing high active Al and Fe content in the volcanic ash soils. The P sorption reaction shows various intermediate properties between adsorption and precipiation depending on the forms of the active Al and Fe. A similarity of P sorption by noncrystalline Al hydroxide to precipitation is obtained from solid-state nuclear magnetic resonance (NMR) spectrometry (Bleam, 1991; Rothwell et al., 1980; Tropp et al., 1983; Williams, 1981; Lookman et al., 1994). Sidebands enhancement with cross-polarization supports a phosphate has P-O-H group (Figure 4a, b). No sideband enhancement (Figure 4f) suggests that the P sorption product is a material close to noncrystalline Al phosphate (Figure 4d). However, the sorption product is not exactly the same with noncrystalline Al phosphate because there is a very small difference between the chemical shift values in Figure 4c and e.

Opaline silica, or a pedogenic opal, was found out as one of the newly formed minerals in young volcanic ash soils (Shoji and Masui, 1971; Shoji and Saigusa, 1978). This mineral is formed from Si released from volcanic ash when solutes in the soil solution are concentrated with drying or freezing.

During the volcanic ash soil formation, some alkaline and alkline-earth elements are eluviated and many heavy metals are concentrated in the soils due to highly sorptive nature of the poorly crystalline components (Masui et al., 1972; Yamasaki et al., 2001; Nanzyo et al., 2002a). Consequently, content of many trace elements in the volcanic ash soils is not lower than those in other soils.

Properties of the volcanic ash soils are dependent on climatic conditions. Under temperate-humid conditions, Andosols in the WRB soil classification system or Andisols in the USDA soil taxonomy is dominantly formed whereas Podzols or Spodosols are formed under cold-humid climatic conditions (Ugolini et al., 1988; Shoji et al., 1988a, b; Takahashi et al., 1989). In the eluvial horizons under podzolization, concentration of Al complexed with soluble humus is high. This feature is reflected in the Al-humus complex accumulated in the illuvial horizon and the Al-humus accumulated under podzolization is highly extractable than those under Andosolization (Shoji and Ito, 1990; Ping et al., 1990; Ito et al., 1991; Shoji and Yamada, 1991). Properties of humus in volcanic ash soils are also affected by biological activities. Black and highly humified humus is accumulated under grass vegetation and dark brown humus with high content of fulvic acid is accumulated under forest vegetation (Takahashi and Shoji, 1988; Shoji et al., 1990a,b; Dahlgren et al., 1991). Human activities contributed to keep grass vegetation under humid climate.

Clay formation is also affected by climatic conditions and soil water movement in soil. Under semi-dry or water-saturated conditions, halloysite is formed rather than allophane and imogolite due to relatively high Si concentration in the soil solution. Some halloysites show high selectivity for K^+ and NH_4^+ compared with Ca^{2+} (Saigusa et al., 1978; Takahashi et al., 1993; Takahashi et al., 2001a).

The volcanic ash soil at Kawatabi Field Center contains large amount of Al-humus complex and 2:1 to 2:1:1 intermediate minerals with scarce amount of allophane and imogolite and shows high acidity.

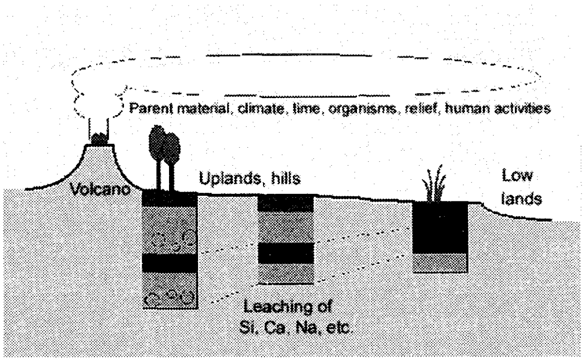

Figure 3. Schematic representation of soil formation processes from volcanic ash deposits.

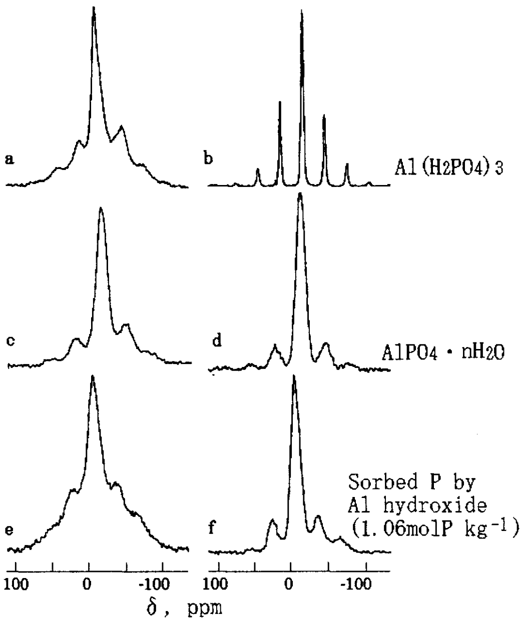

Figure 4. ^{31}P solid-state NMR spectra of P in the reference materials (a, b, c and d) and sorbed P by Al hydroxide (e and f). a,c,e : Without cross polarization (CP). b,d,f : CP with H, contact time=1ms. (Courtesy of K. Deguchi, 1986)

After recognition of nonallophanic volcanic ash soil (Shoji and Ono, 1978; Shoji et al., 1984) originated from the volcanic ash soil at the Kawatabi Field Center, the central concept of Andisols in USDA soil taxonomy was revised from amorphous clay minerals to active Al and Fe (Shoji and Fujiwara, 1984; Shoji et al., 1985; Shoji, 1985). The international type locality of the nonallophanic Andisol was set at the Mukaiyama area of the Kawatabi Field Center. Further, nonallophanic Andosol was newly incorporated in the soil classification system of Japanese cultivated soils in 1995. The nonallophanic Andisols occupy one-third of Japanese Andosols and loess from China is also contained in this soil (Saigusa et al., 1992, Matsuyama et al., 1992; Saigusa et al., 1993a; Matsuyama and Saigusa, 1994a,b; Saigusa and Matsuyama, 1998; Matsuyama et al., 1999a, b). "Volcanic ash soils-genesis, properties and utilization" (Shoji et al., 1993) was published after establishing a database on the properties of volcanic ash soils in the northern part of circum-pacific volcanic zone (Nanzyo and Shoji, 1992; 1993; Shoji et al., 1996).

Biological production

Volcanic ash soils had chemical problems such P deficiency, Al toxicity in the nonallophanic Andosols (Saigusa et al., 1980), rapid nitrogen-fertilizer loss with rain, slow mineralization of organic nitrogen, and so on. However, P deficiency was amended with heavy application of P fertilizers, the Al was detoxified with liming, amelioration of toxic Al in the subsurface horizon was studied using gypsum (Saigusa et al., 1991; Saigusa et al., 1995; Saigusa et al., 1994a,b; Saigusa and Toma, 1997; Saigusa et al., 1997; Toma and Saigusa, 1997a,b; Toma et al., 1999; Takahashi et al., 1999; 2000; Morikawa and Saigusa, 2000a,b; 2002; Takahashi et al., 2001b), and low efficiency of N fertilizer was improved using controlled availability fertilizers. The controlled availability fertilizers are also effective in reducing labor for fertilizer application because the fertilizer can be applied with crop seeds such as rice and dent corn (Saigusa et al., 1993b; Saigusa et al., 1994; Ito et al., 1988, 1997; Ito et al., 2000; Inoue et al., 2000a,b,c,d; Saigusa et al., 2001a,b; Inoue et al., 2001a,b; Taki et al., 2002), and the duration of N-release period can be synchronized with N absorption by crops (Gandeza et al., 1991; Shoji et al., 1991; Shoji and Kanno, 1994). Apatite is included in the fresh volcanic ash and it is utilized by some crops that can exudate chelating organic acids or a large amount of proton from their roots (Nanzyo et al., 1997a; Nanzyo and Yamasaki, 1998; Nanzyo et al., 1999; Nakamaru et al., 2000).

Future prospects

Education and researches on chemical, physical and biological functions of volcanic ash soils in the areas of forests and grasslands will go on further to improve biological production in these areas. High quality, high yield, low cost, saving labors, fertizers and energy, and environmental protection in biological production are the goals of the future researches (Ombodi et al., 1988a, b; 2000a, b; Ombodi and Saigusa, 2000a, b, c, d; Saigusa, 1999; Kosuge et al., 2000; Kosuge et al., 2001a, b, c; Saigusa et al., 2001). Studies on the genetical structure and the gene flow in the forests established on volcanic ash soils lead to elucidation of mechanisms how genetical diversity is maintained in these ecosystems. The effect of different soil colloids on P availability and reactivity with acid deposition will be elucidated using different volcanic ash soils. Moderate Al release from nonallophanic Andosols is effective to controll some soil-born plant diseases (Mizuno et al., 1998; Furuya et al., 1999). P foraging root growth of *Brassica* plants appears effective in improving P efficiency in the Andosols (Nanzyo et al., 1997b; Nanzyo et al., 2002b).

Acknowledgement

The author thanks Professors K. Seiwa, Y. Suyama, T. Takahashi, M. Saigusa and T. Ito for their valuable comments and assistance.

References

Bleam, W. F. 1991. Soil science applications of NMR spectroscopy. Adv. Agr. 46, 91-155.

Dahlgren, R. A., F. C. Ugolini, S. Shoji, T. Ito and R. S. Sletten 1991. Soil-Forming Processes in Alic Melanudands under Japanese Pampas Grass and Oak, Soil Sci. Soc. Am. J., 55,1049-1056

Furuya, H., T. Takahashi and T. Matsumoto. 1999. Suppression of *Fusarium solani* f. sp. *phaseoli* on bean by aluminum in acid soils. Phytopathology, 89, 47-52

Gandeza, A. T., S. Shoji, and I. Yamada. 1991. Simulation of Crop Response to Polyolefin-coated urea (I) Field Dissolution, Soil Sci. Soc. Am. J., 55, 1462-1467.

Inoue, H., T. Ito, and M. Saigusa. 2000a. Weed growth and nutrient uptake in dent corn cultivation with single basal *co-situs* fertilization. Jpn. J. Soil Sci. Plant Nutr. 71, 345-349.

Inoue, H., Ito, T., and M. Saigusa. 2000b. Yield and nutrient uptake of dent corn (Zea mays L.) in no-tillage cultivation with single basal *co-situs* fertilization. Jpn. J. Soil Sci. Plant Nutr. 71, 674-681.

Inoue, H., T. Ito and M. Saigusa. 2000c. Effects of combination of co-situs fertilization and row application of hervicides on the yield of dent corn in no-tillage cultivation. Jpn. J. Soil Sci. Plant Nutr. 71, 682-688.

Inoue, H., T. Ito and M. Saigusa. 2000d. Effects of planting density and application rate of nitrogen fertilizer on lodging and yield of dent corn in no-tillage system, Grassl. Sci. 46, 249-253.

Inoue, H., T. Ito and M. Saigusa. 2001a. Growing reactions of weeds to different methods of fertilizer and herbicide applications in dent corn (Zea mays L.), Tohoku Weed J.1, 21-25

Inoue, H., T. Ito and M. Saigusa. 2001b. Notillage cultivation of corn using controlled release fertilizer, Fertilization in the third millennium-fertilizer, food security and environmental protection pp1028-1034.

Ito T., Y. Yamada and M. Saigusa. 1988. Effects of subsoil and polyolefin-coated urea application on growth and nitrogen uptake of oats and barley in Andisols. Tohoku J. Agr. Res. 49, 25-32.

Ito, T. S. Shoji, Y. Shirato and E. Ono. 1991. Differentiation of a Spodic Horizon from a Buried A Horizon, Soil Sci. Soc. Am. J. 55, 438-442.

Ito, T. H. Inoue and M. Saigusa. 1997. Effects of no-tillage systems on silage-corn yields and soil characteristics in Andisol. Developments in Plant and Soil Sciences 78 Kluwer Academic Publishers 653-654.

Ito, T., H. Inoue, and M. Saigusa. 2000. Effect of tillage and nitrogen fertilizer type on emergence of dent corn in cultivation with single basal co-situs fertilization. Jpn. J. Soil Sci. Plant Nutr. 71, 187-193.

Iwamoto, S., S. Tokumasu, Y. Suyama, M. Kakishima. 2002. Molecular phylogeny of four selected species of the strictly anamorphic genus *Thysanophora* using nuclear ribosomal DNA sequences. Mycoscience 43, 169-180.

Kanno, H., M. Hara, Y., Hirabuki, A. Takehara, and K. Seiwa. 2001. Population dynamics of four understorey shrub species during a 7-yr period in a primary beech forest. J. Vegetation Sci. 12, 391-400.

Kimura, M., K., Seiwa, Y., Suyama, and N. Ueno. 2004. Flowering system of heterodichogamaous Juglans ailanthifolia. Plant Species Biology 18, 75-84.

Kobayashi, S., S. Shoji, I. Yamada and J. Masui,

1976. Chemical and mineralogical studies on volcanic ashes (III) Some mineralogical andchemical properties of volcanic glasses with special reference to the rock types ofvolcanic ashes, Soil Sci. Plant Nutr., 22, 7–13.

Kosuge, S., K. Shibuya, and M. Saigusa. 2000. Single basal application of total nitrogen with controlled availability fertilizers for Chinese cabbage cultivation as a representative autumn leaf vegetables. Bull. Exp. Farm Tohoku Univ. 16, 9–11(2000)

Kosuge, S., Y. Yamada, T. Higashi and M. Saigusa. 2001a. Single basal application of total nitrogen in nursery pot with controlled availability fertilizer in strawberry culture. Jpn. J. Soil Sci. Plant Nutr. 72, 88–91.

Kosuge, S., N. Kuwano and M. Saigusa. 2001b. Single basal application of controlled availability nitrogen fertilizer for tomato cultivation. Jpn. J. Soil Sci. Plant Nutr. 72, 621–626.

Kosuge, S., T. Higashi and M. Saigusa. 2001c. Effects of fertilization methods on N–uptake, vegetative growth and yield of forcing strawberry. J. Japan. Soc. Hotr. Sci. 70, 616–621.

Lookman, R., P. Grobet, R. Merckx and K. Vlassak. 1994. Phosphate sorption by synthetic amorphous aluminium hydroxide : a 27Al and 31P solid–state MAS NMR spectroscopy study. Eur. J. Soil Sci. 45, 37–44.

Masui, J., S. Shoji and K. Minami, 1972. Copper and zinc in volcanic ash soils, Soil Sci. Plant Nutr., 18, 31–37.

Matsuyama, N., M., Saigusa, K., Kikuchi, and T. Abe. 1992. Distribution of allophonic and nonallophanic Andosols in Hokkaido district. Bull. Exp. Farm Tohoku Univ. 8, 13–18.

Matsuyama, N., and M. Saigusa. 1994a. Distribution of allophonic Andosols and nonallophanic Andosols in Japan based on the data of soil survey reports on reclaimed land. Jpn. J. Soil Sci. Plant Nutr. 65, 304–312.

Matsuyama, N., and M. Saigusa. 1994b. Distribution of allophonic Andosols and nonallophanic Andosols in western Japan. Pedologist 38, 2–9

Matsuyama, N., Kudo., K. and M.Saigusa. 1999a. Active Aluminùm of Cultivated Andosols and Related Soil Chemical Properties in Japan, Bull. Fac. Agr. Life Sci. Hirosaki Univ. 1, 30–36.

Matsuyama N., M. Saigusa and K. Kudo. 1999b. Acidity of Japanese cultivated Andosols and significance of exchange acidity y1 in their classification. Jpn. J. Soil Sci. Plant Nutr. 70, 754–761.

Matsuyama, N. and M.Saigusa. 2000. Acidification of Andosols by heavy application of fertilizer, Ibid., pp51–54.

Mizuno, N., H. Yoshida, M. Nanzyo and T. Tadano. 1998. Chemical characterization of conducive and suppressive soils for potato scab in Hokkaido, Japan. Soil Sci. Plant Nutr., 44, 289–295.

Morikawa, K. C. and M. Saigusa. 2000a. Aluminum toxicity under natural leaching condition in Andisols, Mini–reviews on Plant Soil Interaction at Low pH for inviting 6th PSILPH. pp39–43

Morikawa, K. C. and M. Saigusa. 2000b. Mechanism of acidification of soils by the continious application of chemical fertilizer, Ibid., pp44–50.

Morikawa C. K. and M. Saigusa. 2002. Si amelioration of Al toxicity in barley (*Hordeum vulgare* L.) growing in two Andisols, Plant Soil 240, 161–168.

Nagamatsu,Y., K. Seiwa and A. Sakai. 2002. Seedling establishment of deciduous trees in a various topographic positions. J. Vegetation Sci. 13, 35–44.

Nakamaru, Y., M. Nanzyo, and S. Yamasaki. 2000. Utilization of apatite in fresh volcanic ash by Pigeonpea and Chickpea, Soil Sci. Plant Nutr. 46, 591–600.

Nanzyo, M., and S. Shoji. 1992. Properties of Andisols from Northern part of Circum–pacific volcanic zone. I. Physical properties based on Andisol TU database. Pedologist 36, 108–117.

Nanzyo, M., and S. Shoji. 1993. Properties of Andisols from Northern part of Circum–pacific volcanic zone. II. Chemical properties based on Andisol TU database. Pedologist 37, 87–95.

Nanzyo, M. T. Takahashi, A. Sato, S. Shoji and I. Yamada. 1997a. Dilute acid–soluble phosphorus in fresh air–borne tephras and fixation with an increase in active aluminum and iron, Soil Sci. Plant Nutr., 43, 839–848.

Nanzyo, M., H. Kurosaki and S. Yamasaki. 1997b. Characteristics of P supply from polyolefin–coated P fertilizers in soils, Soil Sci. Plant Nutr., 43, 1073–1078.

Nanzyo M. and S. Yamasaki. 1998. Phosphorus bearing mineral in fresh, andesite and rhyolite tephras in northern part of Japan, Phosphorus Research Bulletin 8, 95-100.

Nanzyo, M. Y. Nakamaru and S. Yamasaki. 1999. Inhhibition of apatite dissolution due to formation of calcium oxalate coating, Phosphorus Research Bulletin 9, 17-22.

Nanzyo, M., S. Yamasaki, and T. Honna. 2002a. Changes in content of trace and ultratrace elements with an increase in noncristalline materials in volcanic ash soils of Japan, Clay Sci. 12, 25-32.

Nanzyo, M., Y. Shibata, and N. Wada. 2002b. Complete Contact of *Brassica* roots with Phosphates in a Phosphorus-Deficient Soil, Soil Sci. Plant Nutr. 48, 847-853.

Obayashi, K. Y. Tsumura, T. Ihara, K. Niiyama, H. Tanouchi, Y. Suyama, I. Washitani, C-T. Lee, S. L. Lee, N. Muhammad. 2002. Genetic diversity and outcrossing rate between undisturbed and selectively logged forests of *Shorea curtisii* (Dipterocarpaceae) using microsatellite DNA analysis. International Journal of Plant Science 163 (1) : 151-158.

Ombodi, A., M. Saigusa and K. Shibuya. 1988a. "Effect of single basal application of polyolefincoated fertilizer on growth and yield of green peppers" Tohoku J. Agr. Res. 49, 33-40

Ombodi, A., S. Miyoshi and M. Saigusa. 1988b. Effects of band applications of polyolefin-coat edfertilizer on the nitrate and oxalate content in spinach, Tohoku J. Agri. Res. 49 101-141.

Ombodi, A., S. Kosuge and M. Saigusa. 2000a. Effects of Band Applications of Polyolefin coated Fertilizers on the Nutrtional Quality of Garden Sorrel(*Rumex acetosa* L.), Tohoku J. Agric. Research 50(3-4), 63-69.

Ombdi, A., S. Kosuge and M. Saigusa. 2000b. Effects of polyolefin-coated fertilizers on the nutritional quality of spinach. Journal of Plant Nutrition. 23(10), 1495-1504 (2000)

Ombodi, A., and M. Saigusa. 2000a. Improvement of nitrogen use efficiency of tendergreen mustard grown in the field during rainy seasons by using polyolefin-coated urea, Tohoku J. Agric. Research,51,1-6.

Ombdi, A., and M. Saigusa. 2000b. Broadcast application versus band application using poly olefin-coatedfertilizer on green peppers grown in the field. Journal of Plant Nutrition. 23(10), 1485-1493.

Ombdi, A., and M. Saigusa. 2000c. Effects of a band application of polyolefin-coated diammonium phosphate on the nutritional quality of rhubarb and Swiss chard. International Journal of Horticultural Science. 6, 39-42.

Ombdi, A., and M. Saigusa. 2000d. Reducing nitrate content in lettuce using polyolefin-coated fertilizers. International Journal of Horticultural Science. 6, 35-38.

Ping, C. L., Shoji, S., Toyoaki Ito, J. M. Kimble and F. DeConinck. 1990. Andisol/Spodosol Transition Problems, Proc. 5th International Soil CorrelationMeeting (ISCOM), Characterization, Classification, and Utilization of Spodosols, U.S.A. (1988), pp. 252-266.

Rothwell, W. P., J. S. Waugh, and J. P. Yesinowski. 1980. High-resolution variable-temperature 31P NMR of solid calcium phosphates. J. Am. Chem. Soc. 102, 2637-2643.

Saigusa, M. 1999. Slow-Release Nitrogen Fertilizers and Plant Nutrition in "Nitrogen Nutrituion andPlant Growth" eds by H. S. Srivastava and R. P. Singh, 305-335. Oxford & IBH Publishing Co. LTD. New Delhi

Saigusa, M., S. Shoji and T. Kato. 1978. Origin and nature of halloysite in Ando soils from Towada tephra, Japan. Geoderma 20, 115-129.

Saigusa, M., S., Shoji, and T. Takahashi. 1980. Plant growth in acid Andosols from northeastern Japan : 2, Exchange acidity Y1 as a realistic measure of aluminum toxicity potential. Soil Sci. 130, 242-250.

Saigusa, M. N. Matuyama, T. Honna and T. Abe. 1991. Chemistry and Fertility of acidAndisols with Special Reference to Subsoil Acidity, in "Plant-soil Interaction at Low pH " ed. R. J. Wright et al., 73-80, Kluwer Academic Publishers Netherland.

Saigusa, M., Matsuyama, N., and Abe, T. 1992. Distribution of allophonic Andosols and nonallophanic Andosols in Japan based on the data of soil survey reports on reclaimed land. Jpn. J. Soil Sci. Plant Nutr. 63, 646-651.

Saigusa, M., Matsuyama, N., and Abe, T. 1993a. Distribution of allophonic Andosols and nonallophanic Andosols in Tohoku district. Jpn. J. Soil Sci. Plant Nutr. 64, 423-430.

Saigusa, M., Kodama, H., and K. Shibuya, 1993b.

Single basal application of nitrogen fertilizer on dent corn cultivation using controlled release urea. J. Japan. Grassl. Sci. 40, 44–50.

Saigusa, M., Shibuya, K., and T. Abe. 1994a. Single application of fertilizer in spring on orchard grass (Dactylis glomerata L.) meadow using controlled release coated urea. J. Japan. Grassl. Sci. 41, 95–100.

Saigusa, M., T, Matsumoto, and T .Abe. 1995. Phytotoxicity of Monomer Aluminum Ions andHydroxy–aluminum Polymer ions in an Andosol. R. A. Date et al. (eds) Plant Soil Interaction at Low pH 367–370. Kluwer Academic Publisher Netherland.

Saigusa M., and N. Matsuyama. 1998. "Distribution of allophanic Andosols and Non–allophanicAndosols in Japan" Tohoku J. Agr. Res. 48, 75–83.

Saigusa, M., N., Taki, and K. Shibuya. 2001a. Improvement of the nitrogen application method on grazing pasture using controlled availability fertilizer, Grassl. Sci. 47, 151–156.

Saigusa, M., Taki, N., and Shibuya, K. 2001b. Effects of an applied nitrogen form on nitrogen uptake by grasses in simulated grazing pasture, Grassland Sci. 47, 184–190.

Saigusa M. and M Toma. 1997. Mechanism of reduction of exchangeable aluminum by gypsum application in acid Andosols. Soil Sci. Plant Nutr. 43, 343–349.

Saigusa, M. M. Toma and the late T. Abe. 1994b. Effects of phosopho–gypsum application in top soil on amelioration of subsoil acidity of nonallophanic Andosols, J. Japan. Grassl. Sci. 41, 397–404.

Saigusa, M. M. Toma and M. Nanzyo. 1997. Alleviation of subsoil acidity in nonallophanic Andosols by phosphogypsum application in topsoil. Soil Sci. Plant Nutr. 42, 221, 227.

Saigusa, M., A. Ombodi, T. Oowashi, and H. Watanabe. 2001. Supply of aimed form of nitrogen using controlled availability fertilizer, Fertilization in the third millennium–fertilizer, food security and environmental protection pp315–321.

Saitoh, T., K, Seiwa and A. Nishiwaki. 2002. Importance of physiological integration of dwarf bamboo to persistence in forest understorey : a field experiment. J. Ecology 90, 78–85.

Seiwa, K. 1998. Advantages of early germination for growth and survival of seedlings of *Acer mono* under different overstorey phenologies in deciduous broad–leaved forests. Journal of Ecology, 86, 219–228.

Seiwa, K. 1999a. Changes in leaf phenology dependent on tree height in *Acer mono*, a deciduous broad–leaved tree. Annals of Botany 83, 355–361.

Seiwa, K. 1999b. Ontogenetic changes in leaf phenology of Ulmus davidiana var. japonica, a deciduous broad–leaved tree. Tree Physiology, 19, 793–797.

Seiwa, K. 2000. Effects of seed size and emergence time on tree seedling establishment : importance of developmental constraints. Oecologia 123, 208–215.

Seiwa, K., Watanabe, A., Irie, K., Kanno, H., Saitoh, H, and Akasaka, S. 2002a. Impact of site–induced mouse caching and transport behaviours on regeneration in Castanea crenata Journal of Vegetation Science 13 : 517–526.

Seiwa, K. Watanabe, A. Saitoh, T. Kanno, H., and Akasaka, S. 2002b. Effects of burying depth and seed size on seedling establishment of Japanese chestnuts, *Castanea crenata*.. For. Ecol. Manage. 164 : 149–156.

Shoji, S. 1985. Genesis and properties of non–allophanic Andisols in Japan, Applied Clay Sci., 1, 83–88.

Shoji, S. and Y. Fujiwara. 1984. Active aluminum and iron in the humus horizons of Andosols from northeastern Japan : Their forms, properties, and siginificance in clay weathering, Soil Sci., 137, 216–226.

Shoji, S., and J. Masui, 1971. Opaline silica of recent volcanic ash soils in Japan, J. Soil Sci., 22, 101–108.

Shoji, S. and T. Ito. 1990. Classification of tephra–derived Spodosols, Soil Science, 150, 799–815.

Shoji , S. and H. Kanno. 1994. Use of polyolefin–coated fertilizers for increasing fertilizer efficiency and reducing nitrate leaching and nitrous oxide emissions, Fertilizer Research, 39, 147–152.

Shoji S. and T. Ono. 1978. Physical and chemical properties and clay mineralogy of Andosols from Kitakami, Japan. Soil Sci. 126, 297–312.

Shoji, S. and M. Saigusa. 1978. Occurrence of laminar opaline silica in some Oregon andosols, Soil Sci.Plant Nutr., 24, 157–160.

Shoji, S., S. Kobayashi, I. Yamada and J. Masui, 1975a. Relationships between the geochemistry of ferromagnetic component and the chemicalproperties of air-born pyroclastic materials, J. Japan Assoc. Min. Petr. Econ. Geol., 70, 12-24.

Shoji, S., S. Kobayashi, I. Yamada and J. Masui, 1975b. Chemical and mineralogical studies on volcanic ashes (I) Chemical composition ofvolcanic ashes and their classification, Soil Sci. Plant. Nutr., 21, 311-318.

Shoji, S. T. Ito, M. Saigusa, and I. Yamada. 1984. Properties of nonallophanic Andosols from Japan. Soil Sci., 140, 264-277.

Shoji, S. T. Kurebayashi and I. Yamada. 1990a. Growth and chemical composition of Japanese pampas grass (Miscanthus sinensis) with special reference to the formation of dark-colored Andisols in Northeastern Japan, Soil Sci. Plant Nutr., 36, 105-120.

Shoji, S., T. Kurebayashi, I. Yamada, R. Nira. 1990b. Growth and soil environments of Japanese pampas grass (M. sinensis) as andisolozer innortheastern Japan, Trans. of 14th International Congress of Soil Science, 5, 387-388.

Shoji, S., A. T. Gandeza, and K. Kimura. 1991. Simulation of Crop Response to Polyolefin-coated urea (II) Nitrogen uptakeby corn,Soil Sci. Soc. Am. J., 55,1468-1473 .

Shoji, S., M. Nanzyo and R. A. Dahlgren. 1993. Volcanic Ash Soils-Genesis, Properties and Utilization, Developments in Soil Science 21,, Elsevier, pp. 1-288.

Shoji, S., M. Nanzyo, R. A. Dahlgren and P. Quantin. 1996. Evaluation and proposed revisions of criteria for andosols in the world reference base for soil resources, Soil Sci., 161, 604-615.

Shoji, S., T. Takahashi, T. Ito, and C. L. Ping. 1988a. Properties and classification of selected volcanic ash soils from KenaiPeninsula, Alaska, U.S.A, Soil Sci. 145, 395-413.

Shoji, S., T. Takahashi, M. Saigusa, I. Yamada and F. C. Ugolini. 1988b. Properties of Spodosols and Andisols showing climosequential and biosequentialrelations in southern Hakkoka, northeastern Japan, Soil Sci. 145, 135-150.

Shoji, S., and H. Yamada. 1991. Comparison of mineralogical properties between tephra-derived Spodosols from Alaska and nontephra-derived Spodosols from NewEngland, Soil Sci., 152, 162-183.

Shoji, S., T. Ito, S., M. Saigusa, and I. Yamada. 1985. The case for recognizing .asuborder of non-allophanic Andisols (Allands), Proc. 6thInternational Soil Classification Workshop, Chile/Ecuador. 1, 175-189.

Suyama, Y., K. Obayashi, I. Hayashi. 2000a. Clonal structure in a dwarf bamboo (*Sasa senanensis*) population inferred from amplified fragment length polymorphism (AFLP) fingerprints. Molecular Ecology 9, 901-906.

Suyama, Y., H. Yoshimaru, Y. Tsumura. 2000b. Molecular phylogenetic position of Japanese *Abies* (Pinaceae) based on chloroplast DNA sequences. Molecular Phylogenetics and Evolution. 16, 271-277.

Takahashi, T. and S. Shoji. 1988. Biosequence of Fulvudands and Melanudands in Towada District, North-eastern Japan, Proc. 9th International Soil Classification Workshop, Japan (1987), pp. 535-546.

Takahashi, T., S. Shoji and A. Sato. 1989. Clayey Spodosols and Andisols showing a biosequential relation fromShimokita Peninsula, northeastern Japan, Soil Sci., 148, 204-218.

Takahashi, T., R. A. Dahlgren and P. van Susteren. 1993. Clay mineralogy and chemistry of soils formed in volcanic materials in the xeric moisture regime of northern California. Geoderma 59, 131-150.

Takahashi, T., Sasakai, K., Yokota, K, Ojima, K., and Saigusa, M. 1999. Simple visual detection of Al-tolerance level in plant root by decoloring the filterpaper stained by hematoxylin-study using the root of carrot seedling-. Jpn. J. Soil Sci. Plant Nutr. 70, 554-557.

Takahashi, T., Sasakai, K., Yokota, K, Ojima, K., and Saigusa, M. 2000. Secretion of citric acid from Al-tolerant carrot (*Daucus carota*L.) root. Jpn. J. Soil Sci. Plant Nutr. 71, 365-371.

Takahashi, T., R. A. Dahlgren, B. K. G. Theng, J. S. Whitton and M. Soma. 2001a. Potassium-selective, halloysite-rich soils formed in volcanic materials from northern California. Soil Sci. Soc. Am. J. 65, 516-526.

Takahashi, T., K. Sasakai, H. Okoshi, K. Ojima and M. Saigusa, 2001b. Al tolerance of carrot (Daucus carota L.) S1 lines from selected cell cultures and locational variation of exuding citric acid from their roots. Jpn. J. Soil Sci. Plant Nutr. 72, 49–55.

Taki, N., Saigusa, M., Chiba, T., and Ohta, M. 2002. Influence of controlled availability fertilizer applied in grazing pasture on a cattle body conditon. Bull. Exp. Farm Tohoku Univ. 18, 1–7.

Toma M. and M. Saigusa 1997a. Effects of phosphogypsum on amelioration of strongly acid nonallophanic Andosols, Plant and Soil, 192 49–55 (1997)

Toma, M., and Saigusa M. 1997b. Effect of gypsum on the decomposition of rice straw and rice straw manure. Jpn. J. Soil Sci. Plant Nutr. 68, 645–650(1997)

Toma, M., M. E. Sumner, G. Weeks, and M. Saigusa. 1999. Long-term Effects of Gypsum on CropYield and Subsoil chemical Properties, Soil Sci Soc. Am. J. 39, 891–895.

Tomita, M., Hirabuki and Seiwa, K. 2002. Post-dispersal changes in the spatial distribution of Fagus crenata seeds. Ecology 83 : 1560–1565.

Tropp, J., N. C. Blumenthal, and J. S. Waugh. 1983. Phosphorus NMR study of solid amorphous calcium phosphate. J. Am. Chem. Soc. 105, 22–26.

Tsumura, Y., Y. Suyama, K. Yoshimura. 2000. Chloroplast DNA inversion polymorphism in populations of *Abies* and *Tsuga*. Molecular Biology and Evolution 17, 1302–1312.

Ueno, N. and Seiwa, K. 2003. Importance of habitat selection on sexualdifference in resource acquisition in dioecious tree, Salix hultenii. Journal of Forest Research 8, 9–16.

Ugolini, F. C., R. Dahlgren, S. Shoji and T. Ito. 1988. An example of andosolization and podzolization as revealed by soil solution studies, southern Hakkoda, northeastern Japan, Soil Sci. 145,111–125.

Williams, R. J. P. 1981. Solid state N. M. R. spectroscopy of minerals and soils. J. C. S. Chem. Comm. 1051–1052.

Yamasaki, S., A. Takeda, M. Nanzyo, I. Taniyama, and M. Nakai. 2001. Background levels of trace and ultra-trace elements in soils of Japan, Soil Sci. Plant Nutr. 47, 755–765.