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China aster plant growth, seed yield and quality as influenced by Asahi SL treatment

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ABSTRACT

The aim of the study was to examine the effects of Asahi SL (sodium ortho and para-nitro phenolate, sodium 5 nitro guaiacolate) application on China aster stem length, seed yield and quality. The plants were sprayed with Asahi SL, in concentration of 0.0, 0.1, 0.2 or 0.4%, once during stem or flower bud development or during flowering. Asahi SL applied during flower bud development on tertiary stems or during flowering of flowers on tertiary capitula, increased seed yield, germination and vigour and did not modify vegetative growth of plants. Spraying plants with this compound performed earlier, i.e. during development of primary and secondary stems or buds on primary or secondary stems stimulated vegetative plant growth and decreased seed yield. The chemical used during flower bud development on tertiary stems alleviated also negative

effect of thermal inhibition of high temperature (35°C) on seed germination. The biggest increase in the seed yield was observed after plant spray with Asahi SL at the stage of flowering of flowers on tertiary capitula. Such treatment stimulated mainly seed filling on secondary capitula. Thus, it is needed to carry out studies on the efficiency of later plant treatment with this chemical in the stimulation of seed filling on teriary capitula.

INTRODUCTION

To alleviate negative effects of unfavorable environmental conditions and assure high profitability of seed production a preharvest plant treatment frequently becomes a necessity. However, to achieve the expected results the choice of suitable chemical is very important. It should be effective, ecological, and should alleviate the influence of unfavourable weather conditions. Asahi SL (Asahi Chemical, Japan), previously called Atonik, perfectly fits into the new required technologies for environmental protection. Unlike other plant stimulators, it contains natural compounds (sodium ortho and para-nitro phenolate, sodium 5 nitro guaiacolate) which stimulate many physiological processes. Among others, they increase activity of nitrate reductase (Sharma et al. 1984), concentration of pinitol and the flow of assimilates from a leaf into an ear (Kudrev 1969), as well as content of vitamin C in broccoli and strawberries (Sumati 1989, Cholewiński 1998).

In the previous study we reported the response of Asahi SL after several applications, when active ingredients were affecting China aster plants for at least 1.5 months (Górnik and Grzesik 2002). However, it is still unclear, which stage of plant development plays a crucial role in increasing seed yield and improving seed quality. The answer will enable us to determinate the exact and required period and stage of plant development which should be stimulated by Asahi SL to achieve optimal results.

The aim of the study was to evaluate the effects of plant spray with Asahi SL performed once at different stages of plant development on China aster plant growth and seed production, their germination and vigour, exhibited by electrical conductivity of the leachates and the activity of *in vivo* ACC oxidase and dehydrogenase.

MATERIAL AND METHODS

The experiment was conducted for two years in Research Institute of Pomology and Floriculture, in Skierniewice, in the centre of Poland. To obtain the plants of

China aster (*Callistephus chinensis* Nees L.) 'Aleksandra', commercial seeds were sown in the middle of March into the mixture of peat and sand (1:1, pH 6.5) in plastic pots, 7 cm in diameter. Seedlings were grown under greenhouse conditions. They were planted to the field (sandy loam soil) in the middle of May, spaced 40×45 cm apart in the three replications completely randomized. Fourteen plants were grown on each plot (2.52 m^2). Azofoska was provided in the spring before planting the seedlings (500 kg ha^{-1}). During vegetation, the China aster plants were three times sprayed with foliar fertilizer – Florovit.

Asahi SL (sodium ortho and para-nitro phenolate, sodium 5 nitro guaiacolate) was purchased from a local chemical supplier. Plants were sprayed with Asahi SL, using a handgun sprayer, in concentrations of 0 (plants treated with water served as the control), 0.1, 0.2 or 0.4%. All applications were performed once as follows:

a) during development of primary and secondary stems,
b) during flower bud development on a primary stem,
c) during flower bud development on secondary stems,
d) during flowering of the majority of flowers on secondary capitula,
e) during flower bud development on tertiary stems,
f) during flowering of the majority of flowers on tertiary capitula.

The seeds were considered matured when they exhibited moisture content of 20% and capitula were covered with pappus. Mature seeds were harvested by hand, separately from the primary, secondary, tertiary capitula and from each plot. The seeds, after harvest, were dried down to ca. 8% moisture content at 20°C and 30% relative humidity (RH) for 3 weeks and then weighed. They were stored for 6 months in linen sacks at 5°C and 30% RH in tightly closed containers over silica gel and then subjected to evaluation of germination percentage, electrical conductivity, and activity of *in vivo* ACC oxidase and dehydrogenase.

Germination assays were carried out at constant temperature of 20°C and 35°C in darkness. The seeds were placed on 6 cm Petri dishes (50 achenes per dish, in three replications), on two layers of filter paper moistened with 2.5 cm^3 of water. A seed was regarded as germinated when the radicle had emerged from the pericarp. Electrical conductivity of the leachates, dehydrogenase activity and *in vivo* ACC oxidase activity determined as ethylene production in the presence of ACC were determined according to the method described by Górnik and Grzesik (2002).

The least significance differences (LSD) were calculated at the significance level $p = 0.01$ and 0.05 for the length of stems, percentage of seed germination, seed yield, electrical conductivity, *in vivo* ACC oxidase and dehydrogenase activity.

RESULTS AND DISCUSSION

The obtained results show that Asahi SL applied once affected all examined parameters. Its effect depended on stage of plant development and concentration.

Spraying plants with this preparation performed during development of primary and secondary stems or flower buds on primary or secondary stems stimulated plant growth (Fig. 1). In some cases, such treatment in concentration of 0.2 and 0.4% extended the length of stems by 6 cm in comparison with control. It is in agreement with the experiments of Vasudeva et al. (1981) with coffee (*Coffea arabica* L.) and of Badawy et al. (1984) with chamomile (*Matricaria chamomilla* L.) in which this chemical increased plant height as well as number of branches. According to Mikos-Bielak and Michałek (1999), application of Asahi SL positively affected photosynthetic efficiency of cucumber and potato leaves. In the present study longer stem lengths due to Asahi SL treatments could be directly or indirectly caused by enhanced photosynthetic activity. However, Asahi SL applied after this period, i.e. at the stage of flower bud development on tertiary stems or flowering on tertiary capitula did not affect the growth of stems.

Spraying plants with this chemical during flowering on secondary capitula, flower bud development on tertiary stems or during flowering on tertiary capitula increased seed yield (Fig. 1). The most advantageous Asahi SL application was on the last examined date, i.e. during flowering of the majority of flowers on tertiary capitula. Such treatment in concentration of 0.2% increased seed yield on secondary capitula by 134% and on tertiary capitula by 38%. It was particularly important because seed yield coming from on these capitula provided 90-95% of total yield. The similar findings were also observed in mung bean (Gurbaksh at al. 1981), cucumber (Camargo and Passos 1976), pea (Yadav et al. 1992) and winter maize (Singh et al. 1987). Earlier plant spray with this chemical, i.e. during flower bud development on tertiary stems or during flowering on secondary capitula was not as effective as treatments during flowering on tertiary capitula. On the contrary, Asahi SL applied at earlier plant stages, during development of primary and secondary stems or buds on primary or secondary stems decreased in most cases yield of seeds collected from secondary and tertiary capitula. The higher was the concentration of Asahi SL the worse was the effect of this chemical on seed yield. It might suggest that too high concentration of Asahi SL was used or/and it was applied too early. Consequently, early plant treatment with Asahi SL could stimulate other physiological processes like vegetative growth which was observed in this study.

Germination of seeds at optimal temperature (20°C) was also improved by plant spray with Asahi SL (Fig. 1). The most prominent response was observed when Asahi SL was applied during flower bud development on tertiary stems. Such treatment in concentration of 0.2 or 0.4% enhanced the germination percentage of seed from primary and secondary capitula by 12% and from tertiary capitula by 16%. Also, Siagian et al. (1985) found an increased percentage of *Hevea brasiliensis* seed germination as a result of Asahi SL sprays. Probably, the increase in seed quality resulted from the stimulation of plant metabolism (Zraly 1999) and the increase of assimilate flow (Kudrev 1969).

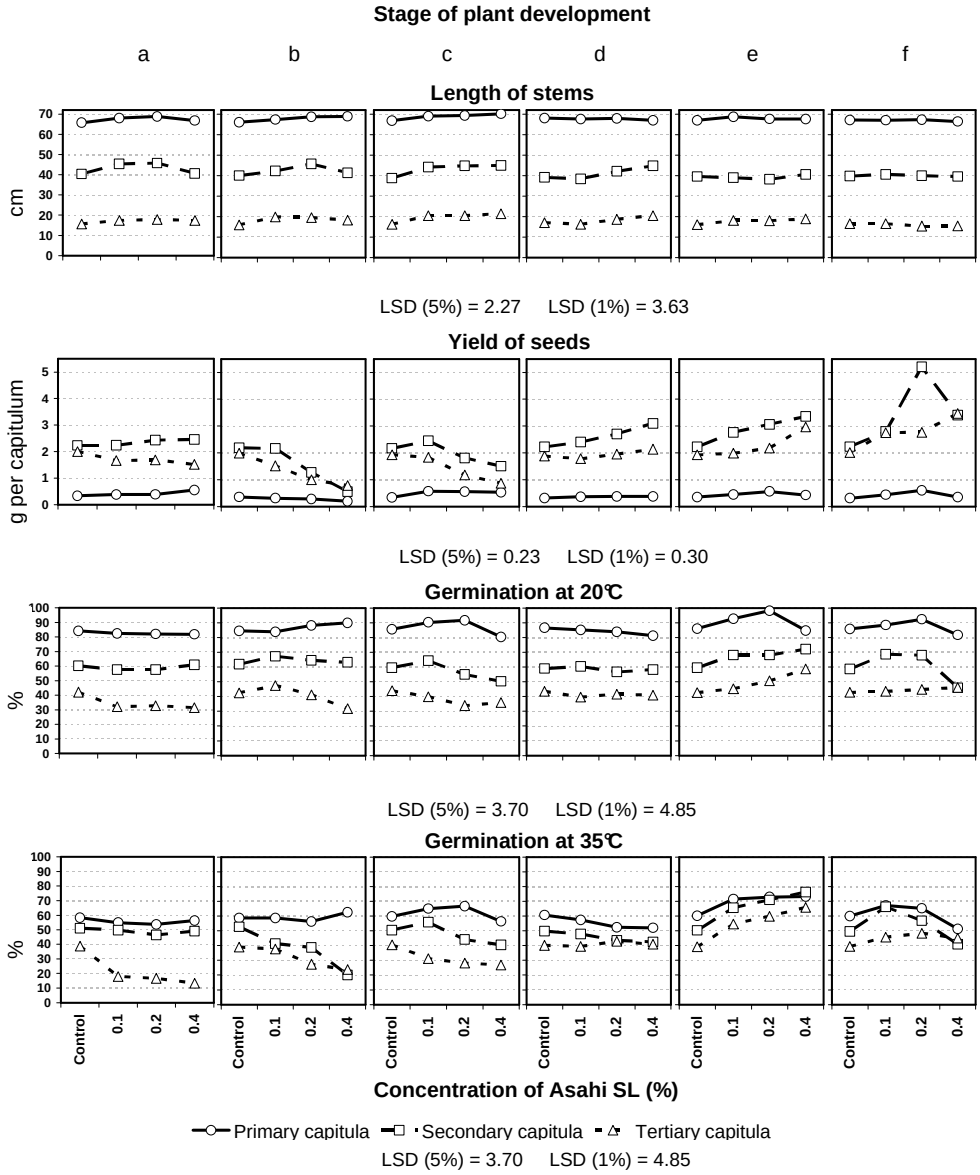

Figure 1. Effect of plant spray with Asahi SL on stem length, yield and germination of China aster seeds collected from primary, secondary and tertiary capitula.
Plant developmental stages during spraying: a) development of primary and secondary stems, b) flower bud development on primary stem, c) flower bud development on secondary stems, d) flowering of the majority of flowers on secondary capitula, e) flower bud development on tertiary stems, f) flowering of the majority of flowers on tertiary capitula

Improvement of seed germination, due to Asahi SL treatment on this date, was even more prominent at 35°C (Fig. 1). Such a result indicated that this chemical alleviated negative effect of thermal inhibition of high temperature (35°C) on seed germination (Fig. 1). The seeds derived from plants not treated with this chemical germinated at this temperature much worse than at optimal temperature.

Asahi SL applications during flower bud development on tertiary stems or during flowering on tertiary capitula enhanced seed vigour, expressed as electrical conductivity, and the activity of *in vivo* ACC oxidase and dehydrogenase (Fig. 2). This chemical applied during flower bud development on tertiary stems and in concentration of 0.4% decreased electrical conductivity in the case of seeds coming from all capitula, indicating improved membrane integrity. Less effective was the spray performed at the stage of flowering on tertiary capitula. Both treatments, during flower bud development on tertiary stems or during flowering on tertiary capitula, caused an increase of *in vivo* ACC oxidase activity in seeds collected from primary, secondary and tertiary capitula. Application of Asahi SL in concentration of 0.2 or 0.4% increased also dehydrogenase activity expressed by a higher content of formazan in seeds. This test indicated that Asahi SL applied on a proper date and in a right concentration enhanced dehydrogenase system of respiratory metabolism in living tissues of seeds. The chemical used earlier, i.e. during flowering on secondary capitula, had no or little effect on activity of the *in vivo* ACC oxidase and dehydrogenase.

Asahi SL spray decreased infection of China aster inflorescences by grey mould (*Botrytis cinerea*), thereby increased the number of flowers capable to form seeds (data not shown). This was particularly important because grey mould poses serious threat to China aster seed and flower production (Paetzke 1987). Occurrence of this disease considerably decreases seed yield and enhances deterioration of seed quality. A decrease of fungi infection due to Asahi SL application was also observed by Saniewska (2000).

The obtained results showed a wide range of possibilities for improving China aster seed yield and quality by foliar Asahi SL sprays. The biggest increase in the seed yield was observed on secondary capitula. It was affected by plant treatment with Asahi SL during flowering on tertiary capitula. This implies that Asahi SL applied during this stage stimulated seed filling mainly on secondary capitula. Presumably later plant treatment with Asahi SL could stimulate better seed filling on tertiary capitula. Therefore, further studies are needed to determine the effect of Asahi SL sprays, performed at the beginning of seed filling on teriary capitula, on yield and quality of seeds.

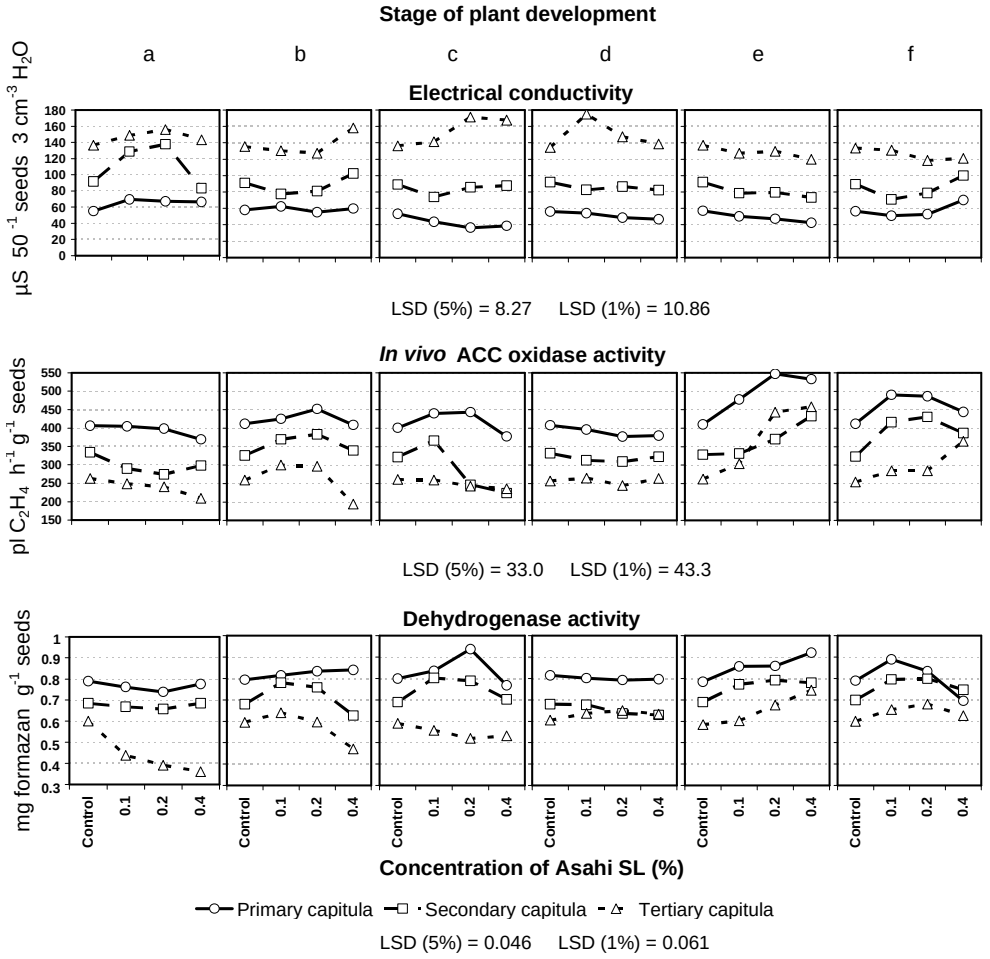

Figure 2. Effect of plant spray with Asahi SL on electrical conductivity, *in vivo* ACC oxidase activity and dehydrogenase activity of China aster seeds collected from primary, secondary and tertiary capitula.

Plant developmental stages during spraying: a) development of primary and secondary stems, b) flower bud development on primary stem, c) flower bud development on secondary stems, d) flowering of the majority of flowers on secondary capitula, e) flower bud development on tertiary stems, f) flowering of the majority of flowers on tertiary capitula

REFERENCES

BADAWY A.A., ABDALLA N.M., RIZK G.A., AHMED S.K., 1984. Influences of Atonik and Atonik-G treatments on growth and volatile oil content of *Chamomilla suaveolens*. Proceedings, eleventh annual meeting. Plant Growth Regulator Society of America, Boston, Massachusetts: 220-223.

CAMARGO L.S., PASSOS F.A., 1976. Preliminary results of the effect of a new plant stimulator on cucumber seed production. Bragantia 35: XCVII-XCIX.

CHOLEWIŃSKI A., 1998. Wstępna ocena wpływu wybranych stymulatorów wzrostu na plon dwóch odmian truskawki w uprawie polowej. 37 Ogólnopolska Naukowa Konferencja Sadownicza, Skierniewice: 57-60.

GÓRNIK K., GRZESIK M., 2002. Effect of Asahi SL on China aster 'Aleksandra' seed yield, germination and some metabolic events. Acta Physiol. Plant. 24(4): 379-383.

GURBAKSH S., KAUR M., SING G., 1981. Effect of growth regulators on podding and yield of mung bean (*Vigna radiata* L. Wilczek). Indian J. Plant Physiol. 24(4): 366-370.

KUDREV T. G., 1969. Some aspects of translocation and accumulation of assimilates in wheat grain in relation to water stress and treatment of the stalk with growth regulators. Symposium on the Mechanism of Fruiting, Translocation and Accumulation of Nutrients in Plant Organism, Warszawa-Skierniewice: 1-4.

MIKOS-BIELAK M., MICHAŁEK W., 1999. Zmiany zawartości barwników asymilacyjnych i aktywności fotosyntetycznej liści ogórków i ziemniaków traktowanych Atonikiem. VIII Ogólnopolski Zjazd Naukowy Hodowców Roślin Ogrodniczych. Hodowla Roślin Ogrodniczych u progu XXI wieku. Lublin: 23-25.

PAETZKE M., 1987. Asters under glass for late cultivation. Deutscher Gartenbau 41(50): 2980-2981.

SANIEWSKA A., 2000. Wpływ preparatu Atonik AL na hamowanie wzrostu i rozwoju niektórych gatunków grzybów chorobotwórczych dla roślin ozdobnych. Zesz. Nauk. ISK Skierniewice 7: 145-153.

SHARMA R., SHARMA B., SINGH G., 1984. Phenols as regulators of nitrate reductase activity in *Cicer arietinum* L. Φyton. 44(2): 185-188.

SIAGIAN N., HARIS U., NURHAWATY S., UHENDI H., 1985. Application of some chemical compounds to shorten the germination period and enhance the germination ability of *Hevea* seeds. Bull. Perkaretan 3(2): 41-48.

SINGH P., PARMAR U., MALIK C.P., SINGH M., BAINS D.S., 1987. A breakthrough in the increase of yield of winter maize (*Zea mays* L. var. Partap) treated with some growth substances. J. Plant Sci. Res. 3: 75-77.

SUMATI E., 1989. The effect of plant growth regulators on vitamin C, water content and weight loss in the broccoli (*Brassica oleracea* var. *italica* L.) cultivar Green Comet. Buletin Penelitian Hortikultura 17(3): 86-90.

VASUDEVA N., RAJU K.I, VENKATARAMANAN D., RATAGERI M.C., 1981. Studies on the effect of Atonik on yield of *Coffea arabica*. J. Coffee Res. 11(2): 39-43.

YADAV A.C, PANDITA M.L., AVTAR S., SINGH G.P., SINGH A., 1992. Effect of Cytozyme, Atonik, Airaculan and Aixtalol on pea (*Pisum sativum* L.) var. bonneville. Haryana J. Agron. 8(1): 75-77.

ZRALY B., 1999. SMART FARMING '99. National Conference on Engineering Smart Farming for the Next Millennium. 14-16 March, Faculty of Engineering. University Putra Malaysia.

WPŁYW PREPARATU ASAHI SL NA ROZWÓJ ROŚLIN ASTRA CHIŃSKIEGO ORAZ PLON I JAKOŚĆ NASION

Streszczenie: Celem badań była ocena wpływu jednorazowego, dolistnego stosowania preparatu Asahi SL (5–nitroguajakolan oraz orto i para nitrofenoalany sodu) na długość pędów oraz plon i jakość nasion wyrażoną zdolnością kiełkowania, elektroprzewodnictwem wód zastoinowych i aktywnością enzymatyczną (*in vivo* oksydazy ACC i dehydrogenaz). Rośliny opryskiwano preparatem w stężeniu 0,0; 0,1; 0,2 i 0,4% w fazie początkowego wzrostu roślin na pędzie głównym oraz I rzędu lub w fazie tworzenia się pąków kwiatowych albo kwitnienia. Wykazano, że Asahi SL zastosowany w fazie tworzenia się pąków kwiatowych na pędach bocznych II rzędu lub w czasie pełni kwitnienia na tych pędach zwiększał plon nasion, poprawiał ich wigor i nie wpływał na wzrost wegetatywny roślin. Preparat stosowany wcześniej, czyli w chwili tworzenia się pędu głównego i I rzędu oraz w czasie formowania się pąków kwiatowych na pędach bocznych I i II rzędu przyspieszał wzrost roślin, ale zmniejszał plon nasion. Opryskiwanie roślin Asahi SL w fazie tworzenia się pąków kwiatowych na pędach bocznych II rzędu łagodziło również niekorzystny wpływ wysokiej temperatury (35°C) na kiełkowanie nasion astra chińskiego. Nasiona pochodzące z roślin nie traktowanych tym preparatem kiełkowały w tej temperaturze znaczenie słabiej niż w temperaturach optymalnych (20°C).

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