Biyoloji Bilimleri Araştırma Dergisi 8 (2): 03-06, 2015
ISSN: 1308-3961, E-ISSN: 1308-0261

Triton-X-405, Brij 35 ve Brij 76 Surfaktanlarının *Lens culinaris* Medik. (Mercimek) Tohumlarının Gelişimi Üzerindeki Etkilerinin Gözlenmesi

Feruzan DANE[1*] Hazal SEZGINER[1] Gülden YILMAZ[1] Halide AKBAŞ[2]
[1]Trakya University, Faculty of Science, Department of Biology, Balkan Campus, 22030 Edirne, Turkey
[2]Trakya University, Faculty of Science, Department of Chemistry, Balkan Campus, 22030 Edirne, Turkey

*Corresponding author:
E-mail: feruzandane@yahoo.com

Received: 09 May 2015
Accepted: 21 June 2015

Özet

Bu çalışmada, polioksietilen (23) lauril eter ($C_{12}E_{23}$) (Brij 35) ve polioksietilen (10) stearil eter ($C_{18}E_{10}$) (Brij 76) ve oktifenol etilenoksit birlikteliğinden oluşmuş bir oktifenol (OP)-tip surfaktan, [4-(1,1,3,3-tetrametilbutil)fenil]-w-hidroksil-(oksi-l, 2-etanedil) (Triton X-405) isimli noniyonik surfaktanların (*Lens culinaris* Medik. cv. Sultan) mercimek bitkisi üzerindeki fitotoksik etkileri incelenmiştir. Mercimek tohumlarının kök uzunlukları 1.00, 0.50, 0.25 and 0,12 g/L (w/v) konsantrasyon oranlarında ve 22 ± 0.5 ºC laboratuvar koşullarında 7 gün ve çimlenme yüzdeleri üzerindeki etkileri ise 2 gün boyunca incelenmiştir. EC_{50} değeri sadece Brij-76'nın 1 g / L konsantrasyonunda tohum çimlenmesi üzerinde görülmüştür. Diğer 3 konsantrasyonda ise fitotoksik ve stimulatör etkiler gözlenmiştir. Fitotoksik etki konsantrasyon arttıkça, stimulatör etki ise konsantrasyon azaldıkça artmıştır.

Anahtar Kelimeler: Brij 35, Brij 76, Triton-X-405, noniyonik surfaktant, stimulator etki, *Lens culinaris*.

An Observation on the Effects of Triton-X-405, Brij 35 and Brij 76 Surfactant on the Development of the Seeds of *Lens culinaris* Medik. (Lentil)

Abstract

In this study, different kinds of solutions of three nonionic surfactants named as polyoxyethylene (23) lauryl ether ($C_{12}E_{23}$) (Brij 35) and polyoxyethylene (10) stearyl ether ($C_{18}E_{10}$) (Brij 76) and an octylphenol (OP)-type surfactant, [4-(1,1,3,3-tetramethylbutyl)phenyl]-w-hydroxily-(oxy-l, 2-ethanediyl) (Triton X-405) were selected to examine their phytotoxic effects. They were evaluated under laboratory conditions using lentil (*Lens culinaris* Medik. cv. Sultan) as a test material. Surfactants used in this study were tested at the concentration ranges of 1.00, 0.50, 0.25, and 0.12 g/L (w/v). The phytotoxic effects were examined on germination rates after 2[th] days and on root elongation after 7[th] days. EC_{50} determined only at 1 g / L concentration of Brij-76. Phytotoxic and stimulator effects has been observed on root growth and on seed germination with the other three concentrations. Phytotoxic effects increase according to the control group as concentration increases, the stimulatory effects increase according to the control group as concentration decreases.

Keywords: Brij 35, Brij 76, Triton X-405, nonionic surfactant, effect, *Lens culinaris.*

INTRODUCTION

Surfactants are amphipathic molecules that lower the surface tension between two liquids or between a liquid and a solid [1]. Surfactants are frequently used in formulation and spray application of foliar-applied agrochemicals to improve performance of the active ingredient in crop production [2]. There are non-ionic surfactants, anionic surfactants and cationic surfactants. Nonionic surfactants are amphipathic molecules consisting of a hydrophobic (alkylated phenol derivatives, fatty acids, longchain linear alcohols, etc.) and a hydrophilic part (generally ethylene oxide chains of various length). Among these the polyoxyethylene-octylphenols (NP-40, TX-100 and TX-114, TX-405), the polyoxyethylene sorbitans (Tween series detergents), the polyoxyethylene alcohols (Lubrol series) and the polyoxyethylene fatty acid ether (Brij series) detergents are particularly popular. Due to their favourable physicochemical properties, non-ionic surfactants are extensively used in many fields of technology and research. Non-ionic surfactants are an integral part of the majority of pesticide formulations[3]. They increase the leaf retention of spray solutions[4], enhance adhesional forces of aqueous droplets on crop leaf surfaces [5] and generally improve the effectiveness of active ingredients [6-7] . Non-ionics are especially useful because of their low sensitivity to water hardness and pH. Since they are compatible with charged molecules, they are easily used in mixtures with other ionic surfactants, which often result in beneficial associations. For instance, non-ionics can help solubilize calcium or magnesium salts of anionics [8]. Detergents with polyoxyethylene head groups may contain alkylpolyethylene ethers with the general formula $C_nH_{2n+1}(OCH_2CH_2)xOH$, or a phenyl ring between the alkyl chain and the ether group. A large proportion of these nonionic surfactants are made hydrophilic by the presence of a polyethylene glycol chain, obtained by the polycondensation of ethylene oxide. They are called polyethoxylated non-ionics [8]. There are lots of studies about the effects of surfactants on plants [8-21].

The aim of this study was to investigate the phytotoxic effects on seed germination and root growth the effects of polyoxyethylene-type (Brij-35 and Brij-76) and octylphenol-type non-ionic surfactant (Triton X-405) non-ionic surfactant solutions under laboratory conditions using lentil (*Lens culunaris* medik. cv. Sultan) as a test material.

MATERIALS AND METHODS

In this study, different kinds of solutions of three nonionic surfactants named as polyoxyethylene (23) lauryl ether ($C_{12}E_{23}$)) and polyoxyethylene (10) stearyl ether ($C_{18}E_{10}$) and an octylphenol (OP)-type surfactant, [4-(1,1,3,3-tetramethylbutyl)phenyl]-w hydroxily-(oxy-l, 2-ethanediyl) prepared by condensing octylphenol with ethylene oxide (EO) and octylphenol (OP)-type surfactant were selected. Trade names for these nonionic surfactants are, Brij 35, Brij 76 and Triton X-405 (Triton X also abbreviated TX) were used. These surfactants were selected because they represent important groups being used in pesticide formulation and in spray application of agrochemicals. Physical and chemical characteristics of the experimental surfactants are given in Table 1.

The lentil (*Lens culinaris* Medik. cv. Sultan) was used in this study. The selected seeds were sterilized with 75% (v/v) ethanol for 2 minutes and with 2.5% (v/v) sodium hypochlorite for 10 minutes. After that they were washed throughly with distilled water. 30 seeds of lentil were put between filter papers in Petri dishes for 48 h at 25 ± 2 ºC in dark conditions. The root tips which have 0.5 mm root elongation were determined as germinated. Then the germinated seeds with primary roots (3–5 mm long) were treated with different concentrations of surfactants for 7 days. Four different surfactant concentrations (1.00, 0.50, 0.25, and 0.12 g/L (w/v) were prepared with distilled water from stock solution (1 g surf./1000 mL) for each surfactant. Control groups were treated only with distilled water. Experiments were made 3 times. Root lengths were measured using a millimeter ruler starting at the onset of incubation, then after 1st, 2nd, 3rd, 4th, 5th, 6th and 7th days. At the end of the 7th day, the total root lengths were measured. Means of the length of lentil root tips and percent of seed germination were determined. The phytotoxicity and stimulatory results were based on the effective concentration that reduced root growth by 50 % (EC_{50}).

RESULTS

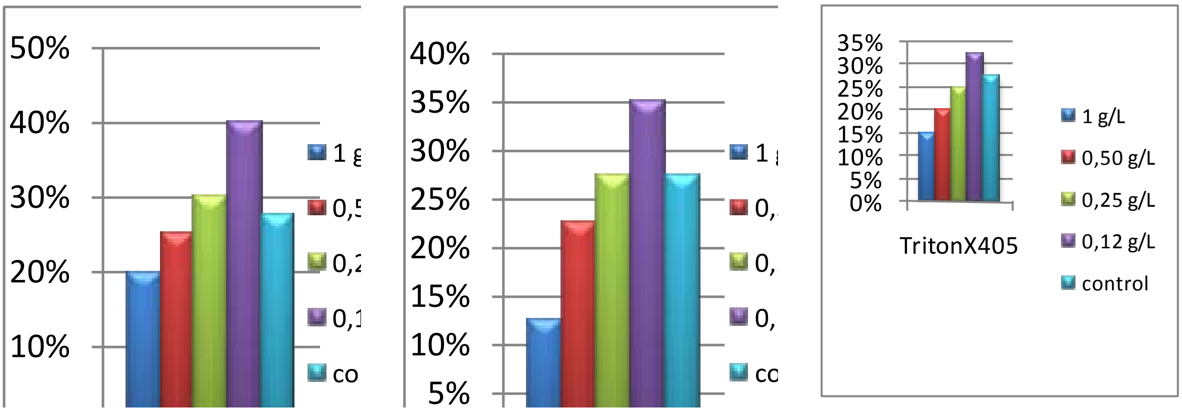
In this study, the phytotoxic and stimulatory effects were observed on germination and root elongation of lentil seeds which were treated by surfactant solutions described above. After the treatment with different concentrations of surfactant, we observed that the percentages of seed germination were decreased while the concentrations were increased. EC_{50} values were not determined at all concentrations of Brij-35, and TX-405 while was determined 1 g / L at concentrations of Brij-76. Germination of lentil seeds at different concentrations of surfactants for 48 hour is seen in Figure 1. Phytotoxic effects were seen on germination of seeds which were treated with 1 g / L and 0.50 g / L at concentrations of Brij-35 and Brij-76. However; stimulatory effetcs were seen on germination of lentil seeds which were treated with 1 g / L, 0.50 g / L, 0.25 g / L concentrations of Triton-X-405. Stimulatory effects were observed on the germination of lentil seeds which were treated with 0.12 g / L concentrations of Brij-76 and Triton-X-405 and 0.25 g / L and 0.12 g / L Brij-35. The stimulatory effect on seed germination increases in the order Brij-35> Brij-76> Triton-X-405. It is observed that while Carbon atom number is increasing, the stimulating effect is decreasing in the Brij series. Triton-X-405 has a differtent structure from the others. It has a phenol group.

Root growth of lentil seeds at different concentrations of surfactant for 7 days is seen in Figure 2. Phytotoxic effects on seed root growth were seen at 1 g / L and 0.50 g / L concentrations of Brij-35 and Brij-76 while it was observed at 1 g / L concentration of Triton-X-405. Stimulatory effects were observed only on the roots of lentil treated with 0.25 g / L and 0.12 g / L concentrations of Brij-35, Brij-76 while it was seen at the 0.50 g / L, 0.25 g / L and 0.12 g / L concentrations of Triton-X-405. The stimulatory effect increases in the order TritonX-405> Brij-76> Brij-35. It is observed that while Carbon atom number is increasing, the stimulating effect is increasing in the Brij series. TritonX-405 has a different structure from the others.

There are many studies about the phytotoxic and stimulatory effects of surfactants on plants [8-22]. However, in this study mostly stimulatory effects were seen. Present results are in agree with the following other studies, which have stimulatory effects too [8,10]. Ethylene oxide is a hormone in plants that helps to grow plant to be mature. So in this study, it could be effective on the root elongation of lentil positively as onion in our recently study [8]. It was determined that because of ethylene oxide in the surfactants stimulatory effects were determined instead of phytotoxic effects of polyoxyethylene type nonionic surfactants (POE) on root elongation of onion.

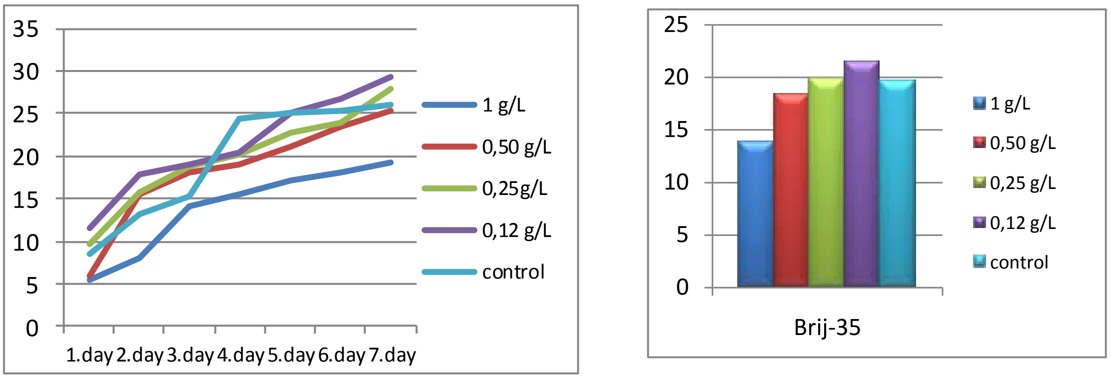
Table 1. Characterization of the experimental surfactants.

Surfactant	Surfactant symbol	Classification	Structural formula
Polyoxyethylene (23) lauryl ether ($C_{12}E_{23}$)	(Brij -35)	Non-ionic	$(C_2H_4O)_{23}C_{12}H_{25}OH$
Polyoxyethylene (10) stearyl ether ($C_{18}E_{10}$)	(Brij-76)	Non-ionic	$C_{18}H_{37}(OCH_2CH_2)_{10}OH$
Octylphenol Ethoxylate	(TX-405)	Non-ionic	$(C_{14}H_{22}O[C_2H_4O]_{35-40})$ [4-(1,1,3,3- tetra methyl butyl) phenyl]-w-hydroxyl -(oxi-l, 2- ethanediyl)

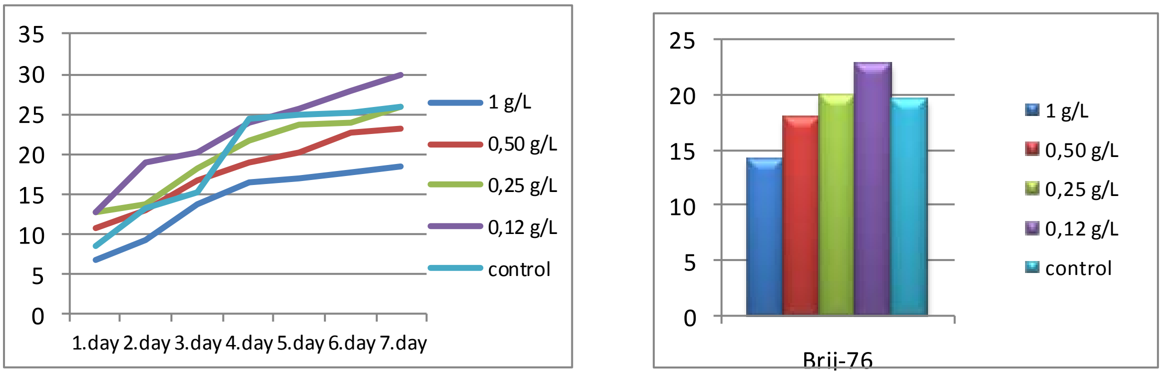


a b c

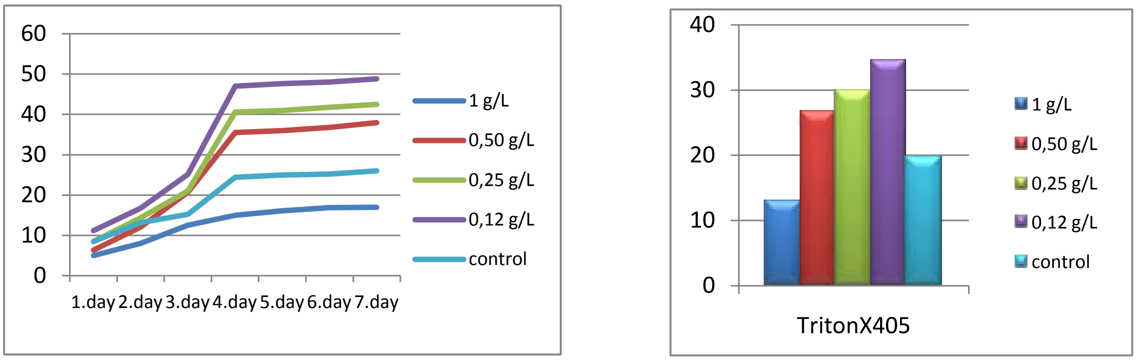
Figure 1. The means of lentil seed germination percent by three nonionic surfactants during 2 days: **a.** Brij-35; **b**. Brij-76; **c.**Triton X-405.



a. Brij-35



b. Brij-76



c. TritonX405

Figure 2. The means of root elongations (mm) of lentil seeds which were treated with three different nonionic surfactants during 7 days: **a.** Brij - 35; **b.** Brij-76; **c.**Triton X-405.

In our previous study, we have reported either the phytotoxic effect or stimulatory effects on root growth for three different octylphenol series non-ionic surfactant, Triton X-114, Triton X-100, Triton X-405 under laboratory conditions using onion [10]. Stimulatory effects only occurred in at 5.00, 2.50 and 1.25 g/L (w/v) concentrations of Triton X-405 while inhibitory effects occured in Triton X-100 and Triton X-114 at all concentrations in our recently study[10]. But also phytotoxic effects of dimeric cationic surfactant Gemini (16-2-16), (16-6-16) and (16-10-16 by Dane et al. [20] and Dimeric Cationic Surfactant (10-2-10), (12-2-12) and CTAB) by Akbaş et al. were examined [21]. Some differences were observed between the effects of these types of cationic surfactants. While the largest inhibitory effects occur in Gemini (10-2-10), the smallest inhibitory effects occurred in Gemini (12-2-12) at 0.156 g/L concentration [21].

CONCLUSION

Surfactants used in this study have opposite effects on germination and root elongation of lentil seed at different concentration. The effect of surfactants in plant growth can not be updated. Different surfactants have different effects on different plants.

The effect of a particular surfactant may vary in different parts of the plant. Recently most studies indicate that the biological effects of surfactant strongly depend on their structure.

REFERENCES

[1] Akbaş, H., Aydemir, M. 2008. Interfacial and micellar properties of anionic azo dye-surfactant binary systems. Colloid Journal. 70: 541-548.

[2] Parr, J.F., Norman, A.G. 1965. Considerations in the use of surfactants in plant systems: A review. Bot. Gaz. 126: 86-96.

[3] Seaman, D. 1990. Trends in the formulation of pesticides an overview. Pestic. Sci. 29: 437-449.

[4] DeRuiter, H., Uffing, A.J.M., Meinen, E., Prins, A. 1990. Influence of surfactants and plant species on leaf retention of spray solutions. Weed Sci. 38: 567-572.

[5] Watanabe, T., Yamaguchi, I. 1993. The specific adhesional forces of aqueous droplets on crop leaf surfaces and factors influencing them. J. Pestic. Sci. 18: 99-107.

[6] Nalewaja, J.D., Palczinski, J., Manthey, F.A. 1990. mazetapyr efficacy with adjuvants and environments. Weed Technol. 4: 765-770.

[7] Nalewaja, J.D., Woznica, Z., Manthey, F.A. 1991. DPXV9360 efficacy with adjuvants and environment. Weed Technol. 5: 92-96.

[8]Yılmaz, G., Akbaş, H., Dane, F., Leventer, S., Öztürk, F. 2012. Micellization and related behaviours of polyoxyethylene-type nonionic surfactants on root elongation of *Allium cepa* L. Asian J. Chem. 24(12): 5743-5745.

[9] Akbaş, H., Dane ,F., Yılmaz, G., Öztürk, F., Leventer, S. 2012. Phytotoxic effects of six surfactants on *Allium cepa* L. plantlets. Fresenius Environmental Bulletin. 21(10): 2853-2858.

[10] Dane, F., Yılmaz, G., Akbaş, H., Öztürk, F., Leventer, S. 2012. Phytotoxic effects of non-ionic surfactant octylphenol series (Triton X-100, Triton X-114, Triton Triton X-405) on Onion. Asian J. Chem. 24(12): 5746-5748.

[11] Yılmaz, G., Dane, F., Turan, F.N. 2012. Morphological and physiological effects of herbicide Attribut (propoxycarbazone- sodium) and surfactant BioPower (sodium alkylether-sulphate) on *Triticum aestivum* L. cv. Pehlivan. Fresenius Environmental Bulletin. 21 (9): 2566-2575.

[12]Yılmaz, G., Dane, F. 2012. Phytotoxicity induced by herbicide and surfactant on stomata and epicuticular wax of wheat. Romanian Biotechnological Letters. 17(6): 7757-7765.

[13] Yılmaz, G., Dane, F. 2013. Phytotoxic effects of herbicide Attribut (propoxycarbazone-sodium) and surfactant BioPower on the root, stem and leaf anatomy of *Triticum aestivum* L. cv. Pehlivan. Turk. J. Bot. 37: 886-893.

[14] Foy, C.L. 1961. Absorption, distribution, and metabolism of 2,2-dichloropropionic acid in relation to phytotoxicity, I.Penetration and translocation of C136 and C 14 labeled dalapon, Plant Physiol. 36: 688-697.

[15] Parr, J.F., Norman, A.G. 1965. Considerations in the use of surfactants in plant systems: A review. Bot. Gaz. 126: 86-96.

[16] Singh, M., Orsenigo, J.R. 1984. Phytotoxicity of nonionic surfactants to sugarcane. Bulletin of Environmental Contamination Toxicology. 32: 119-124.

[17] Sopmeyer, C.S. 1961. Absorption and translocation of foliarly applied phosphorus by loblolly pine seedlings. Plant Physiol. 36: Suppl, xxxiii.

[18] Spurrier, E.C., Jacobs, J.A. 1955. Effect of an anionic sodium sulfonate type surfactant upon plant growth. Agron J. 47: 462-465.

[19] Swanson, C.A., Whitney, J.B. 1953. Studies on the translocation of foliar-applied p32 and other radioisotopes in bean plant. Amer. J. Bot. 40: 816-823.

[20] Dane, F., Akbaş, H., Türkoğlu, M., Leventer, S. 2014. Phytotoxic effects of dimeric cationic surfactant Gemini (16-2-16), (16-6-16) and (16-10-16)." IICBE INT'L conferences (CEBS-2014) Kitabı, 17-18 Eylül 2014, P: 72-75, Kuala Lumpur, MALAYSIA.

[21] Akbaş, H., Leventer, S., Dane, F., Türkoğlu, M., Köse, B. 2014. Katyonik Gemini Surfaktant (10-2-10), (12-2-12) ve Ticari Surfaktant CTAB nın *Allium cepa* L. Üzerindeki Etkileri. Biyoloji Bilimleri Araştırma Dergisi. 7 (2): 06-09-2014.

[22] Yılmaz, G., Aksoy, O., Meriç, Ç., Dane, F. 2013. Effects of herbicide Attribut (propoxycarbazone-sodium) and surfactant BioPower (sodium alkylether-sulphate) on DNA amounts of *Triticum aestivum* L. cv. Pehlivan by flow cytometry. Global Advanced Research Journal of Agricultural Science. 2(12): 322-324.