TARIM BİLİMLERİ DERGİSİ 1999, 5 (2) 30-35

DOI: 10.1501/10.501/Tarimbil_0000000020

Water Quality Parameters in Inflow and Outflow of Sakaryabaşı Trout Farm

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Geliş Tarihi : 21.12.1998

Abstract: This research was conducted to determine the suitability of the Batı Pond (inflow) in terms of water quality standards for trout production and to evaluate its impact on the River Sakarya. For this purpose, several water quality parameters were measured in inflow and outflow of a land-based trout farm over a 12-month period. The results were compared with the literature data. With the exception of total ammonia nitrogen (0.487±0.15 mg/L) and total phosphorus (461.1±81.34 μg/L) values, the measured some physical and chemical parameters (water temperature, dissolved oxygen, pH, conductivity, organic matter, total hardness, bicarbonate alkalinity) of inflow were within the acceptable standard limits for trout production. In the outflow, total ammonia nitrogen, nitrite-nitrogen, nitrate-nitrogen, dissolved reactive phosphorus were within the standard effluent limits. The mean of total phosphorus concentration at the outflow was during the study period averaged (518.5±90.1 μg/L) and the highest total phosphorus concentration was found in May (994.64±4.44 μg/L). High value of total phosphorus was also observed in the inflow, suggesting that water quality control and management of inflow becomes an essential concern.

Key Words: Land-based trout farming, inflow and outflow, water quality parameters

Sakaryabaşı Alabalık Çiftliği Giriş ve Çıkış Suyunun Kalite Özellikleri

Özet: Bu araştırma, Batı Göleti'nin (giriş suyu) alabalık üretimi için su kalite kriterleri açısından uygun olup olmadığını belirlemek ve alabalık yetiştiriciliği çıkış suyunun Sakarya nehri üzerindeki etkisini değerlendirmek için yapılmıştır. Bu amaçla, bir alabalık çiftliğinin (kara-işletmesi) giriş ve çıkış sularında 12 ay süreyle, bazı su kalite parametreleri tespit edilmiştir. Sonuçlar, literatür verileriyle karşılaştırılmıştır. Toplam amonyak azotu (0.487 ± 0.15 mg/L) ve toplam fosfor değerleri (461.1 ± 81.34 μg/L) dışında giriş suyunda ölçülen bazı fiziksel ve kimyasal özellikler (su sıcaklığı, çözünmüş oksijen, pH, kondüktivite, organik madde, toplam sertlik, bikarbonat alkalinitesi) alabalık üretimi için kabul edilebilir standart sınırlar içerisinde bulunmuştur. Çıkış suyunda ise, toplam amonyak azotu, nitrit-azotu, nitrat-azotu, çözünmüş ortofosfat değerleri standart çıkış suyu sınır değerleri içerisindedir. Ancak, çalışma periyodu boyunca çıkış suyu toplam fosfor konsantrasyonu ortalama 518.5 ± 90.1 μg/L olarak tespit edilmiş, en yüksek olarak Mayıs ayında (994.64 ± 4.44 μg/L) bulunmuştur. Giriş suyunda da belirlenen yüksek toplam fosfor değeri, giriş suyunun su kalitesinin kontrol ve yönetiminin üzerinde durulması gereken esas konu olduğunu ortaya koymuştur.

Anahtar Kelimeler: Alabalık çiftliği kara-işletmesi, giriş ve çıkış suyu, su kalite özellikleri

Introduction

Water quality has been considered to be one of the most important factors limiting commercial aquaculture. Several researchers stated water quality standards for aquaculture (Foy and Rosell 1991, Lawson 1995, Solbe 1988, Tarazona and Munoz 1995) and have demonstrated the impact of fish farm waste water discharges including oxygen depression, solid deposition and nutrient enrichment (Kendra 1991, Schwartz and Boyd 1994) on the degradation of the quality of receiving water

The ideal requirement of aquafarm in terms of water pollution is that the quality of their effluents should not differ from that of the inflow water at the head of the system (Mires 1995). Moreover, the parameters of inflow water in a farm are important tools to understand the nature and effects of fish farm effluent on the recipient ecosystems.

Turkish Environmental Legislation has regulated the industrial and domestic effluent requirements through Water Pollution Control Regulation. This Regulation divides the water into four quality classes and states the limits of nitrogen and phosphorus fractions for each water quality (Anonymous 1992). But fish farms effluent standard values are not included in this Regulation.

Rainbow trout (*Oncorhynchus mykiss*) is an important part of Turkish aquaculture sector both in terms of number of farms in operation and production figures Rainbow trout farms constitute 68.55 % of the total number of farms in Turkey and their output corresponding to 44 % of the total amount of farmed fish production (Rad and Köksal 1996).

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Although there is a general increasing trend for aquaculture development in Turkey, there is no information and any research on the impact of fish farming activities in the recipient ecosystems and especially land-based trout farms. Therefore, this study was performed to pay more attention to this issue.

The aim of this research was to evaluate the suitability of water quality parameters in Batı Pond for trout production and to determine whether the fish farm effluents meet the recommended standard levels described in the literatures. It also documents the seasonal changes in water quality parameters in the inflow and outflow waters.

Materials and Methods

This research was carried out in Çifteler-Sakaryabaşı Fish Culture Station. The fish farm surveyed is a on growing trout farm, producing approximately 25 tonnes/year. This station lies within the coordinates of 39°21′15″ N and 39°21′37″ N latidudes and 31°02′02″ E and 31°02′53″ E longitudes with an altitude of 870 m on the Anatolian Plateau (Erençin 1978). The fish farm is located in Sakaryabaşı district where is the origin of River Sakarya emerges (Figure 1). Sakaryabaşı is formed by two springs namely, Doğu and Batı springs and which have a total flow of 2.10 m^3/s and 0.38 m^3/s respectively.

The Batı Pond (Batı spring), is the main water source used in Fish Culture Station for trout on growing. This spring is surrounded by calcareous rocks and has been suffering nutrient enrichment problems accompanied by growth of large filamentous green algae *Cladophora*. These excessive growths affect the amenity value of the pond and sometimes even boating.

Farms' outlet empties directly into River Sakarya. Sakarya River is approximately 824 km long and has a catchment area of 5 816 000 ha (Munsuz and Ünver 1983).

In this study inflow and outflow of a land-based fish farm on River Sakarya were investigated in 1997. Samples were usually collected monthly between 10.00-14.00 hours; Dissolved oxygen, pH, and temperature of inflow samples were analyzed in the field. Samples were analyzed for conductivity, total hardness, bicarbonate alkalinity, organic matter, some phosphorus and nitrogen fractions by using Standard Methods (Anonymous 1975). Outflow water were analysed for phosphorus and nitrogen fractions only.

The factorial analysis of variance was applied to determine the significance of differences between the mean of nitrogen and phosphorus fractions of inflow and outflow waters. Multiple range Duncan's test was applied for assessing the significance of the difference between means (Neter *et al.* 1990).

Results and Discussion

The average values of some physical and chemical parameters of inflow for the entire sampling period are shown in Table 1. As seen in the Table 1, the values of this parameters are suitable for fish production with respect to different documents (Lawson 1995, Solbe 1988).

The concentrations of phosphorus and nitrogen fraction of inflow and outflow of the fish farm are shown in Table 2. The average values for each month are not similar and their differences are statistically significant ($p<0.01$).

All values found in May and June were significantly higher those found in January and February in inflow and outflow. Cripps and Kelly (1995) reported that typical value of total phosphorus in aquaculture effluent water is 0.125 mg/L. Total phosphorus concentrations were higher for most of the year than this value. Diel variations in water pH can play an important role in controlling phosphorus availability in calcareous water bodies (Reddy 1983) but throughout the present study pH of the inflow water reached a max of 8.07 in the December. As seen in Table 2, the amount of phosphorus in outflow water is approximately six times greater in May (994.64 μg/L) than the amount of phosphorus "acceptable" values (170 μg/L) with regard to USEPA (Schwartz and Boyd 1994). Dissolved reactive phosphorus values were found low during the study period (Table 2). None of the dissolved reactive phosphorus samples had concentrations higher than recommended limit (100 μg/L) values as well (Foy and Rosell 1991). Lee (1973) mentioned that this phosphorus fraction is derived from natural sources and is always associated with groundwaters contained in aquifers consisting of quartz and other silicate mineral sands.

Total ammonia nitrogen (TAN) concentrations were low in the winter and high levels occured during July, August, and September. Meade (1985) suggested that the maximum tolerable concentration of ammonia-nitrogen for most fish is about 0.1 mg/L. Recommended levels of total ammonia value (mg/L) and unionized ammonia (mgN/L) are less than 1.0 and 0.02, respectively (Lawson 1995, Tarazona and Munoz 1995). As seen in the Table 2, total ammonia nitrogen values of inflow water exceed the maximum acceptable concentration in these months for fish culture systems. The average total ammonia nitrogen concentration for the United States is 1.77 mg/L (Schwartz and Boyd 1994), whereas mean concentrations of TAN in the outflow water in the present study were below the United States guidelines regarding possible hazards to fish health. According to Schwartz and Boyd (1994), standard average for nitrite-nitrogen is 0.83 mg/L whereas Lawson (1995) has stated this limit as 0.1 mg/L. The upper limit of nitrite-nitrogen in salmonid culture has been estimated

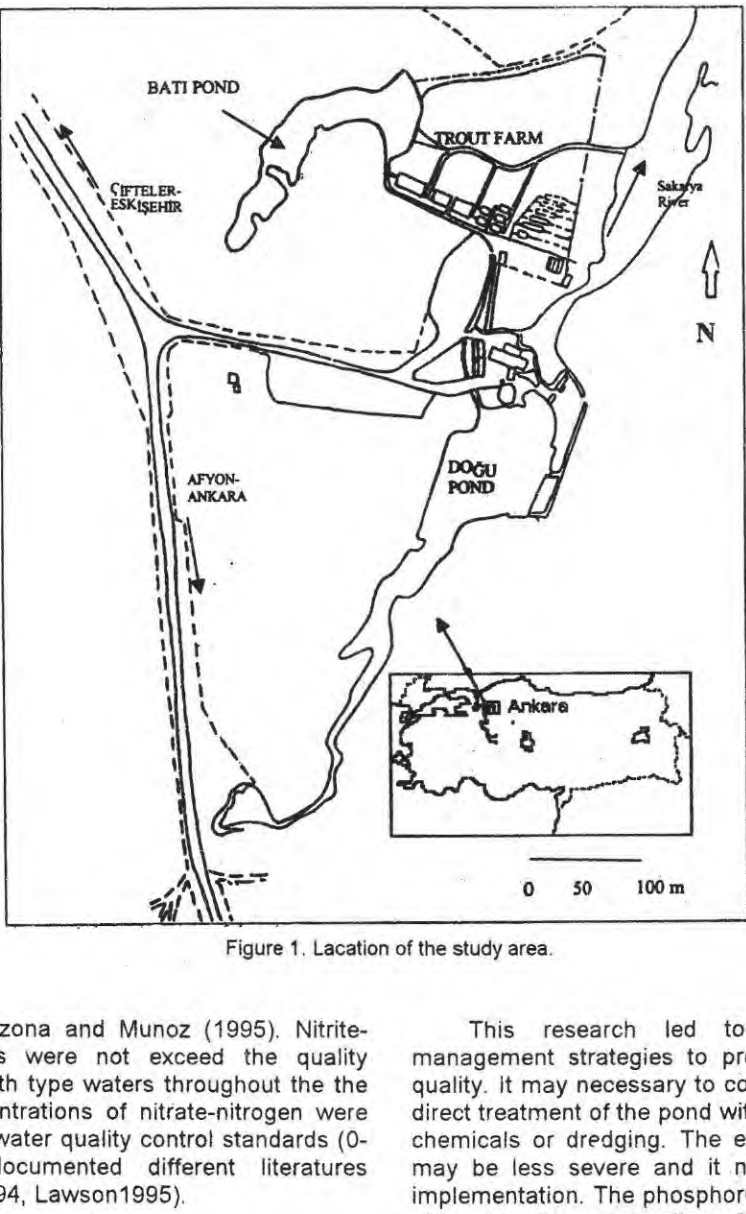

Figure 1. Lacation of the study area.

as 0.01 mg/L by Tarazona and Munoz (1995). Nitrite-nitrogen concentrations were not exceed the quality control standards in both type waters throughout the the year. The mean concentrations of nitrate-nitrogen were considerably less than water quality control standards (0-16.9 mg/L) which documented different literatures (Schwartz and Boyd 1994, Lawson1995).

Conclusion

It was found out that, in terms of certain physico-chemical parameters e.g. water temperature, dissolved oxygen, pH, alkalinity, total hardness of the Batı Pond were between the suitable limits for trout farming. Nevertheless, total ammonia nitrogen and total phosphorus concentrations are quite high for production. Organic matter was found low in inflow. In the inflow waters that the water was influenced by agricultural activities, especially the use of fertilizers on field adjacent to Batı Pond, high concentrations of total phosphorus could be explained by the receiving sewage effluents. Concentrations of total phosphorus of outflow were also high for most of the year when compared with effluent quality standards given in different literatures depending on the initial water quality.

This research led to the generation of a management strategies to protect he Batı Pond water quality. It may necessary to control of phosphorus by the direct treatment of the pond with phosphorus precipitating chemicals or dredging. The effect of localized dredging may be less severe and it needs further study before implementation. The phosphorus removal at the fish farm effluent by the construction of the retention pond can be mentioned together with non-point source control to be implemented in the River Sakarya catchment area.

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Table 1. The variations of some physical and chemical parameters of inflow water during the study period

Parameter / Months		Water temp. (°C)	Dissolved oxygen (mg/L)	PH	Conductivity (µS/cm)	Organic matter (mg/L)	Total hardness (FS°)	Bicarb. alkalinity (mg/L)
January	Min	15.40	7.01	7.80	645.00	3.61	31.70	388.00
	Max	16.01	7.86	7.82	650.00	3.65	32.00	392.00
	Mean±SE	15.70±0.17 ^{HI}	7.24±0.21 ^{B}	7.81±0.005 ^{BCD}	647.75±1.11 ^{F}	3.63±0.01 ^{DEF}	31.85±0.06 ^{F}	389.50±0.96 ^{BC}
February	Min	16.00	7.51	7.60	750.00	3.16	31.80	500.00
	Max	16.70	8.10	7.78	760.00	4.11	33.50	620.00
	Mean±SE	16.35±0.20 ^{GH}	7.85±0.13 ^{A}	7.68±0.04 ^{E}	755.00±2.04 ^{B}	3.63±0.20 ^{DEF}	32.60±0.44 ^{F}	570.00±26.50 ^{A}
March	Min	17.00	7.56	7.09	754.00	2.53	37.20	348.00
	Max	17.40	7.70	7.11	760.00	3.47	39.00	352.00
	Mean±SE	17.20±0.11 ^{FG}	7.65±0.03 ^{AB}	7.10±0.005 ^{G}	757.50±1.50 ^{B}	3.00±0.20 ^{F}	37.90±0.40 ^{E}	349.75±0.85 ^{C}
April	Min	19.50	7.60	7.83	718.00	2.84	39.50	375.00
	Max	20.00	7.67	7.90	722.00	3.79	40.00	400.00
	Mean±SE	19.80±0.12 ^{D}	7.63±0.01 ^{AB}	7.87±0.015 ^{B}	720.00±0.82 ^{D}	3.31±0.20 ^{EF}	39.75±0.10 ^{DE}	385.00±5.40 ^{BC}
May	Min	21.20	6.60	7.69	712.00	3.79	41.40	360.00
	Max	22.00	6.70	7.80	714.00	4.74	42.00	400.00
	Mean±SE	21.68±0.19 ^{C}	6.65±0.03 ^{C}	7.75±0.023 ^{D}	713.00±0.41 ^{E}	4.27±0.20 ^{CDEF}	41.70±0.13 ^{CD}	385.00±9.57 ^{BC}
June	Min	21.10	6.30	7.84	736.00	4.42	41.50	340.00
	Max	23.00	6.41	7.85	740.00	5.05	41.80	480.00
	Mean±SE	22.05±0.55 ^{C}	6.38±0.03 ^{CD}	7.84±0.002 ^{BC}	738.50±0.96 ^{C}	4.74±0.13 ^{BCD}	41.65±0.06 ^{CD}	390.00±31.10 ^{BC}
July	Min	24.70	6.04	7.78	725.00	8.53	45.20	460.00
	Max	25.10	6.05	7.80	726.00	8.85	48.60	520.00
	Mean±SE	24.90±0.09 ^{A}	6.04±0.01 ^{D}	7.79±0.005 ^{CD}	725.50±0.26 ^{D}	8.76±0.08 ^{A}	46.17±0.81 ^{B}	490.00±12.90 ^{AB}
August	Min	23.00	6.06	7.35	609.00	7.58	46.00	260.00
	Max	23.90	6.11	7.37	615.00	7.90	46.80	580.00
	Mean±SE	23.45±0.26 ^{B}	6.08±0.01 ^{D}	7.36±0.005 ^{F}	612.00±1.29 ^{G}	7.74±0.09 ^{A}	46.42±0.19 ^{B}	412.50±68.00 ^{BC}
September	Min	18.00	5.85	7.37	717.00	2.21	43.20	400.00
	Max	19.40	6.91	7.41	729.00	6.00	43.60	480.00
	Mean±SE	18.70±0.40 ^{E}	6.63±0.26 ^{C}	7.39±0.01 ^{F}	723.25±2.84 ^{D}	4.50±0.87 ^{BCDE}	43.42±0.08 ^{C}	435.00±20.60 ^{BC}
October	Min	17.50	7.28	7.04	648.00	4.74	43.00	400.00
	Max	18.20	7.33	7.06	650.00	6.32	43.30	460.00
	Mean±SE	17.95±0.17 ^{EF}	7.30±0.01 ^{B}	7.05±0.005 ^{G}	649.00±0.41 ^{F}	5.60±0.42 ^{B}	43.15±0.06 ^{C}	420.00±14.10 ^{BC}
November	Min	14.50	7.50	7.80	794.00	4.00	48.80	500.00
	Max	15.00	7.53	7.85	799.00	4.38	55.00	560.00
	Mean±SE	14.75±0.14 ^{I}	7.51±0.01 ^{AB}	7.82±0.011 ^{BCD}	796.75±1.03 ^{A}	4.19±0.09 ^{CDEF}	51.92±1.78 ^{A}	540.00±14.10 ^{A}
December	Min	12.80	7.50	7.07	790.00	5.05	34.00	560.00
	Max	13.20	8.10	7.08	798.00	5.68	34.30	600.00
	Mean±SE	13.02±0.08 ^{J}	7.91±0.14 ^{A}	8.07±0.003 ^{A}	794.75±1.70 ^{A}	5.37±0.13 ^{BC}	34.17±0.06 ^{F}	575.00±9.57 ^{A}

*Different letter designate a statistically significant difference ($p<0.01$).

Table 2. The concentrations mean ± SE of water quality variables of samples collected from the inflow (I) and outflow (O) of a trout farm during the study period.
(All caps letters indicate differences between inflow and outflow of months separately. Small caps letters indicate differences between inflow and outflow in each month.)

Months \ Parameter		Total phosphorus (μg/ L)	Total reactive phosphorus (μg/ L)	Dissolved reactive phosphorus (μg /L)	Particulate inorganic phosphorus (μg/ L)	Nitrite-nitrogen (mg /L)	Nitrate-nitrogen (mg /L)	Total ammonia-nitrogen (mg/ L)
January	I	$_{a}$128.56±0.16 ^{I}*	$_{a}$41.46±0.13 ^{G}	$_{a}$3.960±0.015 ^{J}	$_{a}$37.50±0.11 ^{I}	$_{a}$0.0055±0.00 ^{C}	$_{a}$0.1207±0.0042 ^{E}	$_{a}$0.1787±0.0016 ^{CDEF}
	O	$_{b}$111.677± 1.31 ^{K}	$_{b}$51.25±0.58 ^{J}	$_{b}$2.435±0.125 ^{I}	$_{b}$48.81±0.71 ^{J}	$_{a}$0.0075±0.0005 ^{C}	$_{a}$0.129±0.001 ^{E}	$_{a}$0.2131±0.0076 ^{DEF}
February	I	$_{a}$120.15± 1.31 ^{I}	$_{a}$77.89±0.00 ^{F}	$_{a}$6.565±0.196 ^{I}	$_{a}$71.33±0.19 ^{H}	$_{a}$0.0067±0.0002 ^{C}	$_{a}$0.1318±0.0003 ^{E}	$_{a}$0.2216±0.00 ^{CD}
	O	$_{b}$141.10± 0.66 ^{J}	$_{b}$87.71±1.97 ^{I}	$_{b}$9.577±0.028 ^{H}	$_{b}$78.13±1.94 ^{I}	$_{a}$0.085±0.0005 ^{C}	$_{a}$0.2605±0.002 ^{E}	$_{a}$0.2190±0.0136 ^{DEF}
March	I	$_{a}$214.07± 2.29 ^{G}	$_{a}$89.80±5.46 ^{E}	$_{a}$8.422±5.95 ^{H}	$_{a}$86.38±0.43 ^{G}	$_{a}$0.0530±0.0005 ^{A}	$_{a}$0.5005±0.005 ^{D}	$_{a}$0.2155±0.0005 ^{CDE}
	O	$_{a}$230.10± 0.66 ^{I}	$_{b}$114.29±3.54 ^{G}	$_{b}$11.454±0.011 ^{G}	$_{b}$102.83±3.52 ^{G}	$_{b}$0.0106±0.0003 ^{B}	$_{a}$0.5953±0.002 ^{D}	$_{a}$0.2393±0.0026 ^{DE}
April	I	$_{a}$589.40± 0.66 ^{E}	$_{a}$276.85±0.54 ^{B}	$_{a}$9.535±0.029 ^{G}	$_{a}$267.32±0.51 ^{C}	$_{a}$0.0097±0.0007 ^{C}	$_{a}$0.4415±0.001 ^{D}	$_{a}$0.2068±0.0027 ^{CDE}
	O	$_{b}$696.00±6.03 ^{E}	$_{b}$174.37±1.52 ^{F}	$_{b}$28.544±0.693 ^{C}	$_{b}$145.83±0.83 ^{F}	$_{a}$0.0120±0.0001 ^{B}	$_{a}$0.7140±0.002 ^{CD}	$_{a}$0.2669±0.0008 ^{D}
May	I	$_{a}$742.87±0.98 ^{B}	$_{a}$226.05±0.79 ^{D}	$_{a}$13.155±0.025 ^{E}	$_{a}$212.89±0.81 ^{E}	$_{a}$0.0187±0.0007 ^{B}	$_{a}$0.5423±0.002 ^{D}	$_{a}$0.2603±0.0043 ^{C}
	O	$_{b}$994.64±4.44 ^{A}	$_{b}$249.97±0.08 ^{E}	$_{b}$52.635±0.015 ^{A}	$_{b}$197.33±0.10 ^{E}	$_{a}$0.00135±0.0001 ^{B}	$_{b}$1.2919±0.001 ^{B}	$_{a}$0.2859±0.0003 ^{D}
June	I	$_{a}$861.65±2.62 ^{A}	$_{a}$245.79±0.53 ^{C}	$_{a}$24.468±0.102 ^{B}	$_{a}$221.32±0.42 ^{D}	$_{a}$0.008±0.001 ^{C}	$_{a}$1.3637±0.001 ^{B}	$_{a}$0.3618±0.0032 ^{B}
	O	$_{b}$904.18±3.27 ^{B}	$_{b}$288.64±1.38 ^{D}	$_{b}$30.550±0.320 ^{B}	$_{b}$258.08±1.07 ^{D}	$_{b}$0.0146±0.0001 ^{B}	$_{a}$1.3940±0.003 ^{B}	$_{a}$0.5390±0.0003 ^{C}
July	I	$_{a}$741.89±0.66 ^{B}	$_{a}$226.05±0.78 ^{D}	$_{a}$20.927±0.788 ^{C}	$_{a}$205.12±1.58 ^{F}	$_{a}$0.0132±0.0007 ^{B}	$_{a}$1.4760±0.005 ^{AB}	$_{a}$1.3154±0.013 ^{A}
	O	$_{b}$800.16±3.34 ^{C}	$_{b}$351.64±0.40 ^{C}	$_{b}$27.575±0.545 ^{C}	$_{b}$324.06±0.14 ^{B}	$_{a}$0.0182±0.0003 ^{B}	$_{a}$1.7075±0.005 ^{A}	$_{a}$1.4325±0.0048 ^{B}
August	I	$_{a}$643.39±0.98 ^{D}	$_{a}$383.16±0.53 ^{A}	$_{a}$16.395±0.110 ^{D}	$_{a}$366.76±0.42 ^{A}	$_{a}$0.008±0.0005 ^{C}	$_{a}$1.5928±0.0003 ^{AB}	$_{a}$1.3770±0.0054 ^{A}
	O	$_{a}$629.97±2.62 ^{F}	$_{b}$399.65±0.37 ^{A}	$_{b}$26.265±0.355 ^{D}	$_{b}$373.39±0.02 ^{A}	$_{b}$0.0224±0.044 ^{A}	$_{a}$1.740±0.010 ^{A}	$_{a}$1.5757±0.146 ^{A}
September	I	$_{a}$702.29±0.98 ^{C}	$_{a}$376.82±2.11 ^{A}	$_{a}$36.585±0.079 ^{A}	$_{a}$339.73±2.02 ^{B}	$_{a}$0.0027±0.0002 ^{C}	$_{a}$1.722±0.015 ^{A}	$_{a}$1.3446±0.0032 ^{A}
	O	$_{b}$724.86±1.97 ^{D}	$_{b}$387.62±1.65 ^{B}	$_{b}$17.890±0.140 ^{E}	$_{b}$369.73±1.79 ^{A}	$_{b}$0.0145±0.0041 ^{B}	$_{a}$1.5464±0.0004 ^{AB}	$_{a}$1.4051±0.184 ^{B}
October	I	$_{a}$422.51±0.66 ^{F}	$_{a}$232.11±0.52 ^{D}	$_{a}$11.580±0.030 ^{F}	$_{a}$220.52±0.49 ^{D}	$_{a}$0.002±0.0005 ^{C}	$_{a}$1.057±0.026 ^{C}	$_{a}$0.1296±0.0022 ^{EF}
	O	$_{b}$476.83±2.62 ^{G}	$_{b}$288.98±1.72 ^{D}	$_{b}$13.240±0.280 ^{F}	$_{b}$275.74±2.01 ^{C}	$_{b}$0.0155±0.0035 ^{B}	$_{a}$0.9841±0.078 ^{C}	$_{a}$0.0919±0.0003 ^{G}
November	I	$_{a}$144.70±1.63 ^{H}	$_{a}$22.56±0.007 ^{H}	$_{a}$1.803±0.008 ^{K}	$_{a}$20.76±0.01 ^{K}	$_{a}$0.0065±0.0005 ^{C}	$_{a}$0.902±0.0025 ^{C}	$_{a}$0.0907±0.00 ^{F}
	O	$_{b}$266.76±3.27 ^{H}	$_{b}$104.99±2.21 ^{H}	$_{a}$1.450±0.01 ^{I}	$_{b}$103.54±2.21 ^{G}	$_{b}$0.0128±0.0003 ^{B}	$_{a}$0.8047±0.0015 ^{CD}	$_{a}$0.1351±0.0003 ^{FG}
December	I	$_{a}$221.60±1.31 ^{G}	$_{a}$36.32±0.52 ^{G}	$_{a}$4.42±0.015 ^{J}	$_{a}$31.90±0.51 ^{J}	$_{a}$0.002±0.00 ^{C}	$_{a}$0.4423±0.0013 ^{D}	$_{a}$0.1420±0.0016 ^{DEF}
	O	$_{b}$245.81±16.36 ^{I}	$_{b}$91.38±0.66 ^{I}	$_{b}$1.915±0.055 ^{I}	$_{b}$89.46±0.71 ^{H}	$_{b}$0.0199±0.0002 ^{B}	$_{b}$1.3775±0.340 ^{B}	$_{a}$0.1691±0.0003 ^{EFG}

* Different letter designate a statistically significant difference ($p<0.01$).

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