

# Spinach cultivars demonstrate significantly improved germination and growth performance when propagated in OASIS® AeroSelect™ PlugSheet compared to OASIS® AeroMax™ PlugSheet

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**Introduction**

OASIS® engineered growing media is renowned for the propagation of clean, uniform and consistent quality young plants. OASIS® AeroFamily Substrates are exclusively developed for precision hydroponic farming in controlled growing environments. OASIS® AeroMax™ PlugSheet is designed to create a drier root zone environment and is primarily geared towards production under temperate conditions and for crops and systems that have lower water demand. OASIS® AeroSelect™ PlugSheet is designed to enhance moisture in the root zone and is primarily geared towards production under warmer climatic conditions and for crops and systems that have higher water demand. Differences in the advanced surfactant technology and finer cell structure of OASIS® AeroSelect™ PlugSheet allow the matrix to hold more water and have superior capillary action. Apart from these differences, OASIS® AeroMax™ PlugSheet and OASIS® AeroSelect™ PlugSheet have the same density, strength and product makeup.

Spinach is becoming more and more popular among Controlled Environment Agriculture (CEA) growers. One of the main challenges with growing spinach hydroponically is poor and inconsistent germination and young plant establishment, and most of this is associated with the nature of the seed itself (e-Gro Edible Alert; Volume 8 Number 12 August 2023). The germination rate varies significantly among the cultivars as well. Research indicates that precise moisture management and temperature control can improve germination rate and seedling establishment.

**Objective**

The objective of this study was to gain understanding regarding the effect of two substrates with varying moisture-holding capacities on germination rate and young plant growth of three spinach cultivars: ‘Sunangel’, ‘Red Tabby’ and ‘Carmel.’ OASIS® AeroMax™ PlugSheet growing media has lower water-holding capacity and OASIS® AeroSelect™ PlugSheet has higher water-holding capacity. The effect of vermiculite top dressing over seed was also studied in this experiment.

**Materials & Methods**

This experiment was conducted during the month of November 2023 at our Research, Innovation & Development (RI&D) facility in Kent, Ohio USA. Plant material used for this study was Spinach ‘Sunangel’, ‘Red Tabby’ and ‘Carmel’ purchased from Johnny’s Selected Seeds. Two substrates, OASIS® AeroMax™ PlugSheet and OASIS® AeroSelect™ PlugSheet, with and without vermiculite top dressing, were considered in this study.

**Table 1**

Physical properties of OASIS® AeroMax™ PlugSheet and OASIS® AeroSelect™ PlugSheet

Properties	OASIS® AeroMax™ PlugSheet	OASIS® AeroSelect™ PlugSheet
pH	5.0–5.8	5.0–5.8
EC (mS/cm)	0.2–0.4	0.2–0.4
Total Porosity (%)	95–99	90–95
Air Porosity (%)	10–15	5–10
Water Holding Capacity (%)	80–85	85–90
Bulk Density (kg/m3)	12–16	12–16
Initial Moisture Content (%)	0	0

Table 2

Treatment details

Treatment #	Substrate Type	Vermiculite Covering	Variety	Seeds/Dibble
1	OASIS® AeroMax™ PlugSheet	+	Sunangel	5
2	OASIS® AeroSelect™ PlugSheet	+	Sunangel	5
3	OASIS® AeroMax™ PlugSheet	-	Sunangel	5
4	OASIS® AeroSelect™ PlugSheet	-	Sunangel	5
5	OASIS® AeroMax™ PlugSheet	+	Red Tabby	5
6	OASIS® AeroSelect™ PlugSheet	+	Red Tabby	5
7	OASIS® AeroMax™ PlugSheet	-	Red Tabby	5
8	OASIS® AeroSelect™ PlugSheet	-	Red Tabby	5
9	OASIS® AeroMax™ PlugSheet	+	Carmel	5
10	OASIS® AeroSelect™ PlugSheet	+	Carmel	5
11	OASIS® AeroMax™ PlugSheet	-	Carmel	5
12	OASIS® AeroSelect™ PlugSheet	-	Carmel	5

Note: Sheet growing media with 104-cell count and multi-seed dibble were used in this study. The dibble diameter is 3/4" (0.95 cm). The vermiculite used was medium-size horticultural grade.

#### Experimental Details

##### Initial Watering and Setup

It must be noted that OASIS® AeroMax™ PlugSheet and OASIS® AeroSelect™ PlugSheet growing media ship completely dry and have no starter nutrient charge. Therefore, it is critical to thoroughly saturate the media with nutrient solution to obtain the best performance. For this study, the sheets were watered using sub-irrigation followed by overhead watering to ensure there were no dry spots and pH and EC were equilibrated. First, sheets were placed in a standard 10x20 tray with drain holes, followed by a solid bottom 10x20 tray. Next, sheets were watered overhead with 16-4-17 at 125 ppm N until the trays were filled (6-7.5 L or ~2 gal) to fully saturate the substrate. After 1-2 minutes, the sheets were removed from the solid bottom tray and allowed to drain. Then, the sheets were watered overhead with 5 L (~1.5 gal) nutrient solution. For complete detailed procedures, refer to the product usage sheet.

##### Seeding, Top Dressing and Germination

After watering, 5 seeds were placed per dibble in each of the treatment sheets. For each cultivar and each substrate, seeds in one set of trays were covered with vermiculite, while seeds in the other set were left exposed. The trays of seeded sheet growing media were then covered with a 1020 tray for darkness and then placed directly in the greenhouse. After 48 hours, the tray covers were removed. The trays were left in the greenhouse and misted with nutrient solution.

##### Water & Nutrients

Nutrient solution was made with Kent, Ohio municipal water (EC 0.31 mS/cm, pH 7.46 and Alkalinity 49.56 mg/L) using 16-4-17 OASIS® Hydroponic Fertilizer at 125 ppm N. The young plants were watered every day or as required with nutrient solution by overhead watering using a hose and a breaker from day 4 after seeding onward.

##### Growing Conditions

The greenhouse heating and venting set points were adjusted to maintain 72°F (22°C) during daytime and 70°F (21°C) during nighttime. A 16-hour day length was provided by supplementing natural light with LEDs (Phillips Lighting, GP LED Production 2.2 DR/W/FR150 LB HO NA), and DLI was targeted at around 17-18 moles/day. When light levels exceeded 600 µmol/m<sup>2</sup>/s at the plant canopy level, the greenhouse was covered with shade curtains. The greenhouse relative humidity was maintained between 50% and 60%.

**Observations**

Each treatment had 3 replicates containing 32 plugs per replication. Percent germination was recorded and photographed on day 7 after seeding. On day 15, young plants were harvested, and fresh weights of shoots were recorded. The data was subjected to ANOVA analysis using Statistica™ 13.5.0.17 software program (TIBCO Software Inc. 1984-2018). If significant effects were found between treatments, the mean values were compared using the Tukey's test with significant level of at least  $P < 0.05$ . Photos were taken periodically during propagation.

**Germination Rates**

Among the three spinach varieties tested, 'Sunangel' and 'Red Tabby' generally had better germination rates compared to 'Carmel', which had poorer germination rates. Between the two substrates, spinach propagated in OASIS® AeroSelect™ PlugSheet had better germination rates compared to OASIS® AeroMax™ PlugSheet. The differences were statistically significant in 'Red Tabby' and 'Carmel', while a similar trend in 'Sunangel' was not significantly different (Fig. 1-3). Vermiculite top covering improved the germination and establishment of seedlings in both substrates. (Fig. 1-3). The differences were not always statistically significant but were visibly apparent, as shown in the photos that follow.

**Seedling Fresh Weight**

With all three spinach varieties, 'Sunangel', 'Red Tabby' and 'Carmel', statistically significant higher fresh weights were recorded when grown in OASIS® AeroSelect™ PlugSheet compared to OASIS® AeroMax™ PlugSheet (Fig. 4-6). Vermiculite top dressing further increased the fresh weights of the seedlings in OASIS® AeroSelect™ PlugSheets. However, the differences were statistically significant only with 'Carmel' (Fig. 4-6).

**Conclusions**

All three spinach varieties in this study demonstrated better germination performance and young plant growth in OASIS® AeroSelect™ PlugSheets compared to OASIS® AeroMax™ PlugSheets. In general, vermiculite top dressing improved seedling establishment and plant growth in both substrates. From these trials, it can be concluded that the higher moisture content and capillary action offered by OASIS® AeroSelect™ PlugSheets supported improved spinach germination even with 'Carmel', which had the worst germination rate among the three varieties studied. It appears that vermiculite top dressing further assisted with moisture retention and anchoring of the seedlings by creating mechanical pressure on the top. In conclusion, spinach germination rate and consistency can be improved significantly by propagating with OASIS® AeroSelect™ PlugSheet substrate, particularly in conjunction with preferred spinach varieties and vermiculite top dressing.

**Fig. 1A–E**

Spinach 'Sunangel' 7 days after seeding in 104-count plug sheets. Fig. 1A&C are OASIS® AeroMax™ PlugSheets, and Fig. 1B&D are OASIS® AeroSelect™ PlugSheets. (A&B are without and C&D are with vermiculite top dressing.) Fig. 1E is a graphical presentation of data. For data points assigned the same letters, differences are not statistically significant.



**Fig. 2A–E**

Spinach 'Red Tabby' 7 days after seeding in 104-count plug sheets. Fig. 2A&C are OASIS® AeroMax™ PlugSheets, and Fig. 2B&D are OASIS® AeroSelect™ PlugSheets. (A&B are without and C&D are with vermiculite top dressing.) Fig. 2E is a graphical presentation of data. For data points assigned the same letters, differences are not statistically significant.



**Fig. 3A–E**

Spinach 'Carmel' 7 days after seeding in 104-count plug sheets. Fig. 3A&C are OASIS® AeroMax™ PlugSheets, and Fig. 3B&D are OASIS® AeroSelect™ PlugSheets. (A&B are without and C&D are with vermiculite top dressing.) Fig. 3E is a graphical presentation of data. For data points assigned the same letters, differences are not statistically significant.





Fig. 4A–E

Spinach 'Sunangel' 15 days after seeding in 104-count plug sheets. Fig. 4A&C are OASIS® AeroMax™ PlugSheets, and Fig. 4B&D are OASIS® AeroSelect™ PlugSheets. (A&B are without and C&D are with vermiculite top dressing.) Fig. 4E is a graphical presentation of data. For data points assigned the same letters, differences are not statistically significant.

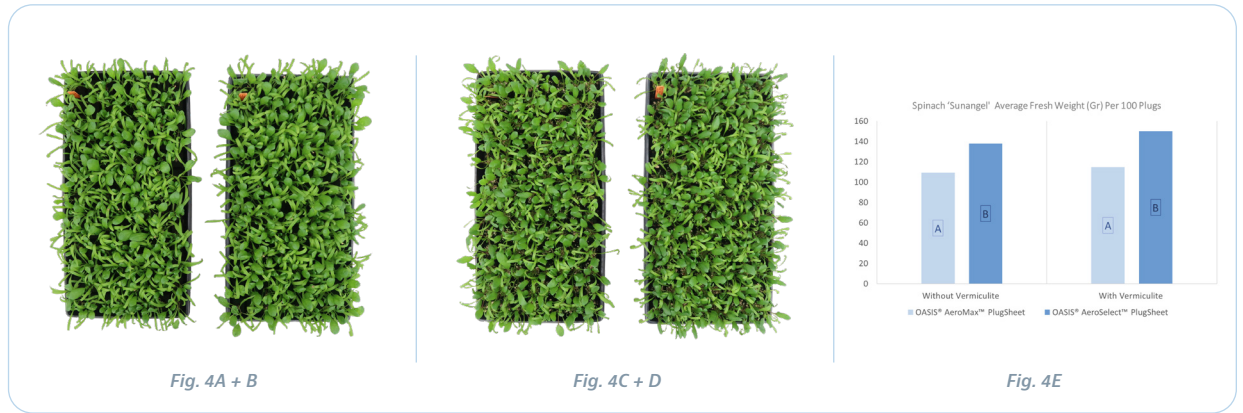


Fig 5A–E

Spinach 'Red Tabby' 15 days after seeding in 104-count plug sheets. Fig. 5A&C are OASIS® AeroMax™ PlugSheets, and Fig. 5B&D are OASIS® AeroSelect™ PlugSheets. (A&B are without and C&D are with vermiculite top dressing.) Fig. 5E is a graphical presentation of data. For data points assigned the same letters, differences are not statistically significant.



Fig. 6A–E

Spinach 'Carmel' 15 days after seeding in 104-count plug sheets. Fig. 6A&C are OASIS® AeroMax™ PlugSheets, and Fig. 6B&D are OASIS® AeroSelect™ PlugSheets. (A&B are without and C&D are with vermiculite top dressing.) Fig. 6E is a graphical presentation of data. For data points assigned the same letters, differences are not statistically significant.

