Maize Plant Growth and Yield Response to JumpStart® LCO

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Introduction

In 2013, Novozymes BioAg introduced JumpStart LCO, a LCO (lipo chitooligosaccharide), *Penicillium bilaiae* combination. Jumpstart LCO combines two unique seed treatment products to create synergy in early root growth in addition to quick emergence, early vigor, greater stress tolerance, and earlier, more even maturity. The Penicillium bilaiae also promotes greater phosphate use efficiency by colonizing on plant roots, releasing organic compounds that release the "bound" mineral forms of less available soil and fertilizer phosphate, making it immediately available for the crop to use. Both products are widely used on numerous crops such as soybean (*Glycine max*), canola (*Brassica napus L.*), lentils (*Lens culinaris*), alfalfa (Medicago sativa) and as in the case of this study, maize (*Zea mays*). The intent of the study was to identify and measure the response of maize seedlings to an application of Jumpstart LCO compared to an untreated check.

Greenhouse seed treatment testing showed increased leaf chlorophyll and overall plant dry weight for maize seedlings. In addition, seedlings were scanned for root area, diameter and length with very significant responses to the treatment. In replicated field trials, maize seed treated with LCO helped increase yield. In 2012, the average yield increase recorded from Novozymes testing sites was a significant response of 3.34 bu/ac (+2%) against the untreated check. Improvement in emergence, early seedling vigor and overall plant dry biomass from LCO treatment of the seed together led to higher plant vigor and potential yield.

Material and Methods

Seed treatment application was made on May-03-2013 according to protocol.Soil was placed in 3-inch pots; 3-seeds per pot were planted. One pot equals one replicate.

Test plants were placed in research greenhouse Zone 3 on a wire-mesh raised bench and arranged in a randomized complete block design with total of ten replicated. Research greenhouse is monitored by Procom, Micro-Grow Greenhouse System temperature control system. Environmental conditions averaged high temperature 87F to low temperature 76F during study dates. Average humidity levels ranged from 40% to 90%. Test plants received natural lighting for duration of study. Test plants were soil-watered every 24-hours or as needed using a hand-held sprinkler. Prior to evaluations, plants were thinned to one (1) plant per replicate.

Root scans were conducted at 21 and 65 days after planting using a root scanner. Plants were carefully removed from the pots and gently rinsed of all soil particles. Plant roots were removed and scanned for length and area to calculate surface area and root volume by the formula of "Diamavg= Projected area / Total length". This formula is based on the assumption that roots are round. From this hypothesis, root height, surface area, and volume can be calculated from the measured diameter with simple trigonometric formula. The surface area and volume calculations per diameter class are computed precisely with the real root diameter. For each pixel of the skeleton, the root volume and surface area are calculated with the punctual root diameter at the pixel position and added to the proper diameter class. This method is more precise than estimating the class volume and area from the class average diameter. Punctual Diameter; in order to study root length per diameter distribution, root diameter is measured continuously along the root. For all pixels belonging to the skeleton, root diameter is defined as: Diameter = smallest distance between two opposite sides' boundary pixels in all directions at this point. Root measurements were collected from all ten replicates and entered into ARM. Analysis was performed using Student-Newman-Kuels with a P-value of 0.01.

EMERGE = plants emerged

0-3 = 3 seeds per container

HEIGHT = shoot height measured from soil level to extended tip of leaf

CM = centimeters; reported as an average of plants in replicate

WEIFRE = fresh weight

WEIDRY = dry weight

LENGTH = total root length (number of pixels in the root skeleton) x (pixel size) WinRHIZO scans all pixels of the analyzed image (skeleton) and adds to each of them a correction that takes into account the direction of movement in the image. WinRHIZO also detects forks and crossings in the image and adds or subtracts length to compensate for overlapping and forks.

PROAREA = projected area measured by counting the number of pixels belonging to the root in the pixels classification image. This count is then multiplied by the pixel area (pixel area = pixel width x pixel height),

SURAREA = surface area

AVG DIA = average diameter

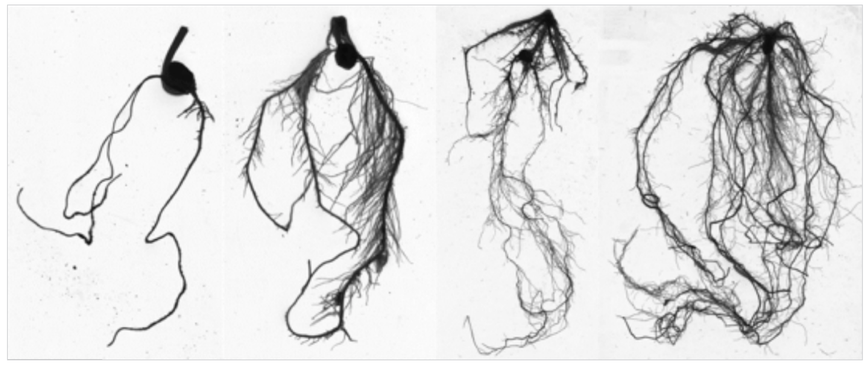
ROOTVOL = root volume

Table 1 (post scan measurements)

	LENGTH/CM 25 DA-A	LENGTH/CM 69 DA-A	SURAREA/CM² 25 DA-A	SURAREA/CM² 69 DA-A	ROOTVOL/CM³ 25 DA-A	ROOTVOL/CM³ 69 DA-A
Untreated Check	30.023 b	1058.815 b	7.827 b	119.312 b	0.164 b	1.087 b
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
JumpStart LCO	81.395 a	1519.101 a	19.344 a	183.5 a	0.377 a	1.776 a
	271.11%	143.47%	247.13%	153.80%	230.49%	163.40%
LSD (P=.01)	0.2302t	394.49	0.1541t	53.71	0.5090t	0.65
Standard Deviation	0.1471t	271.42	0.0985t	36.95	0.3253t	0.45
CV	8.64	21.06	8.74	24.41	11.14	31.30

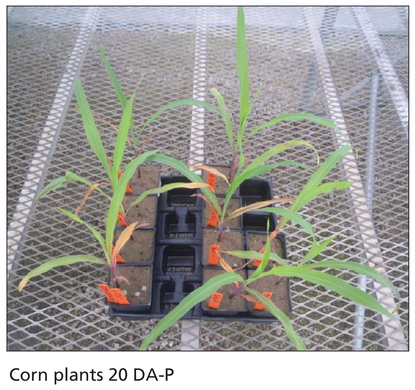
Table 2 (post scan measurements)

	AVG DIA/MM 25 DA-A	AVG DIA/MM 69 DA-A	TIPS/NUMBER 25 DA-A	TIPS/NUMBER 69 DA-A	FORKS/NUMBER 25 DA-A	FORKS/NUMBER 69 DA-A
Untreated Check	0.863 a	0.360 b	65.7 b	119.312 b	74.6 b	8005.5 b
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
JumpStart LCO	0.757 a	0.384 a	166.5 a	183.5 a	380.5 a	11638.5 a
	87.717%	106.49%	-247.13%	253.62%	509.89%	145.38%
LSD (P=.01)	0.0434t	0.0606	0.23t	741.34	0.44t	3524.03
Standard Deviation	0.0277t	0.0417	0.14t	510.06	0.28t	2424.61
CV	10.77	11.22	7.13	21.34	12.6	24.69



Pictures from left to right: UTC @ 25 DA-A, JS LCO @ 25 DA-A, UTC @ 69 DA-A, JS LCO @ 69 DA-A

Untreated vs LCO treated corn seed



Corn plants 20 DA-P

Summary and Results

Root scans from the two sampling dates show a very significant response in root development and growth. The response can be measured in both surface area and root volume as well as in the number of root tips. The JumpStart LCO seed treatment appears to have a greater affect earlier in the growth of the maize seedlings as indicated by the higher ratio of response in the measurements at the 25 day sampling period. Root surface area for the JumpStart LCO measured 19.344 cm2 compared the untreated surface area of and the root volume measured 7.827 cm2. This was an increase of 147.13%. Correspondingly, the root volume for JumpStart LCO calculated to be 0.337 cm3 compared the untreated root volume of 0.164 cm3 for an increase of 130.49%. However, when comparing the average diameter of the two treatments, the roots of the treated seedlings show a smaller diameter. This would be accounted for by an increase in the number of new auxiliary roots that have smaller diameters but larger surface area due to the overall higher number of roots. This is collaborated by the increase in root tips. The treated seedlings measured approximately 100 more root tips (166.5 compared to 65.7) and therefore indicated that the increased volume derives mostly from an increase in root number instead large increases in root diameter. Furthermore, the increase in root number in addition to increased surface area allows the seedlings to interact with a larger portion of the soil profile.

The root response continues to show in the later sampling at 65 days. The increase in root volume, surface area and root tips is not as great but still very significant. When the samples were taken at 65 days, root surface area measured 183.5 cm2 for the treated seed and only 119.3 cm2 on the control, for an increase of 53.8%. As would be expected, root volume response was similar to surface area with a value of 1.78 cm3 for the treated and 1.09 cm3 for water alone, calculating to be a 63.4% increase from the JumpStart LCO. The number of root tips also shows a very significant response at this timing with a count of 380.5 for the treated and only 74.6 with the check.

The research seems to support the claims that JumpStart LCO enhances root and shoot development thus maximizing early season growth. The increased root mass increases nutrietnt uptake while P. bilaiae unlocks "bound" phosphate. The end result is improved plant health and higher yields."

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