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—Scientific Note—

Pre-planting and Supplementary In-season Liquid Phosphorus Fertilization for Potato in Florida

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Potato tuber yield responds to soils with high P content and have responded to phosphorus (P) fertilizer application, despite applications not being recommended. The objectives of this field experiment were to evaluate the effect of four P-fertilizer rates (0, 56, 112, and 168 kg·ha^{-1} P_2O_5) applied pre-plant (P_{pp}), combined with in-season liquid P-fertilizer applications of 0 and 28 kg·ha^{-1} P_2O_5 (phosphoric acid) applied at emergence (P_{eme}) and at tuber initiation (P_{ini}). The combination of P rates and application timing resulted in a total of sixteen P-fertilizer application treatments. Chipping potato 'Atlantic' was planted in January 2019 and 2020 in Hastings, FL. Soil samples were collected at 0-15, 15–30, and 30–45 cm soil depth before treatment applications and after tuber initiation for soil available P (Mehlich-3) and pH. Petiole samples were collected on a weekly basis from 35 to 75 days after planting for P concentration assessment. Before plant senescence, aboveground and tuber tissues were collected for total dry biomass accumulation and total P uptake. Total and marketable yield (tubers diameter >4.8 cm) were measured.

Initial soil available P was 128–151 and 137–160 mg·kg^{-1} in 2019 and 2020, respectively. In both years, there were no significant interactions among P_{pp}, P_{eme}, and P_{ini} for dry biomass accumulation, P uptake, total and marketable yield. Dry biomass accumulation and P uptake responded to P_{pp} in both seasons. In 2019, dry biomass accumulated with 168 kg·ha^{-1} P_2O_5 was 11.2 Mg·ha^{-1}, which was 1.1 Mg.ha^{-1} greater than with 56 kg·ha^{-1} P_2O_5 (Table 1). In 2020, the biomass accumulated (9.10 Mg·ha^{-1}) with zero P_{pp} was significantly lower than the 11.38 Mg.ha^{-1} accumulated with 112 kg·ha^{-1} P_2O_5. For both seasons, the total plant P uptake ranged from 18.86 to 22.84 kg·ha^{-1} P. In 2019, 168 kg.ha^{-1} P_2O_5 resulted in a uptake of 3.5 kg·ha^{-1} greater than potatoes fertilized with 56 kg·ha^{-1} P_2O_5. In 2020, there were no differences in P uptake among P_{pp} rates of 56, 112 and 168 kg·ha^{-1} P_2O_5 with zero applied P-fertilizer, resulting in lower plant P uptake. Supplemental liquid P-fertilizer only affected dry biomass accumulation in 2019. With 28 kg·ha^{-1} P_2O_5 at P_{ini}, the accumulated biomass was 10.9 Mg·ha^{-1}, which was 540 kg·ha^{-1} greater than the dry biomass accumulated when no liquid fertilizer at that stage.

Table 1. Effect of pre-planting (P_{pp}), emergence (P_{eme}), and tuber initiation (P_{ini}) P-fertilization dry biomass and plant phosphorus (P) uptake of potato cultivated in Hastings, FL in 2019 and 2020.

	Total biomass (Mg·ha^{-1})		Total uptake (kg·ha^{-1} P)	
P-fertilizer rate	2019	2020	2019	2020
P_{pp} (kg·ha^{-1} P_2O_5)				
0	10.53 ab[y]	9.1 b	20.14 ab	16.59 b
56	10.13 b	10.18 ab	19.35 b	18.86 a
112	10.66 ab	11.38 a	20.49 ab	20.85 a
168	11.23 a	9.84 ab	22.84 a	19.14 a
P_{eme} (kg·ha^{-1} P_2O_5)				
0	10.89 a	10.11 ns	20.95 ns	18.67 ns
28	10.39 b	10.14 ns	20.45 ns	19.05 ns
P_{ini} (kg·ha^{-1} P_2O_5)				
0	10.36 b	9.92 ns	19.71 ns	18.01 ns
28	10.91 a	10.33 ns	21.68 ns	19.71 ns

[y]Mean values followed by different lowercase letters denote significant differences at $P < 0.05$ according to Tukey test. Absence of letters denotes means are nonsignificant.

Tuber total and marketable yield responded similarly to P_{pp} in both seasons. Overall yield in 2019 was higher in 2020 and may be due to a relatively drier season in 2020. Total yield responses to P_{pp} are in Fig. 1. In 2019, total yield (41 Mg·ha^{-1}) with 56 kg·ha^{-1} P_2O_5 was significantly lower than the 45.3 Mg·ha^{-1} with 168 kg·ha^{-1} P_2O_5. However, there were no significant differences between total yield obtained when applying 0, 112, and 168 kg·ha^{-1} P_2O_5. In 2020, total yield with zero P_{pp} was 33.3 Mg·ha^{-1} which increased significantly by 4.1, 5.2, and 5.1 Mg·ha^{-1} with P_{pp} rates of 56, 112, and 168 kg·ha^{-1} P_2O_5, with no significant differences with P_{pp} rates. Total and marketable yield only responded to supplementary P fertilization at P_{pp} in 2019 (Table 2). Total yield and marketable yield were significantly higher with 28 kg·ha^{-1} P_2O_5 at P_{ini} when compared to a P_{pp} rate of zero P.

Based on current University of Florida/IFAS interpretations of soil P content, for soils with a P content between 137–160 mg·kg^{-1} (Mehlich-3), no (0) kg·ha^{-1} P_2O_5 is recommended. This means that no response to added P fertilizer should be expected.

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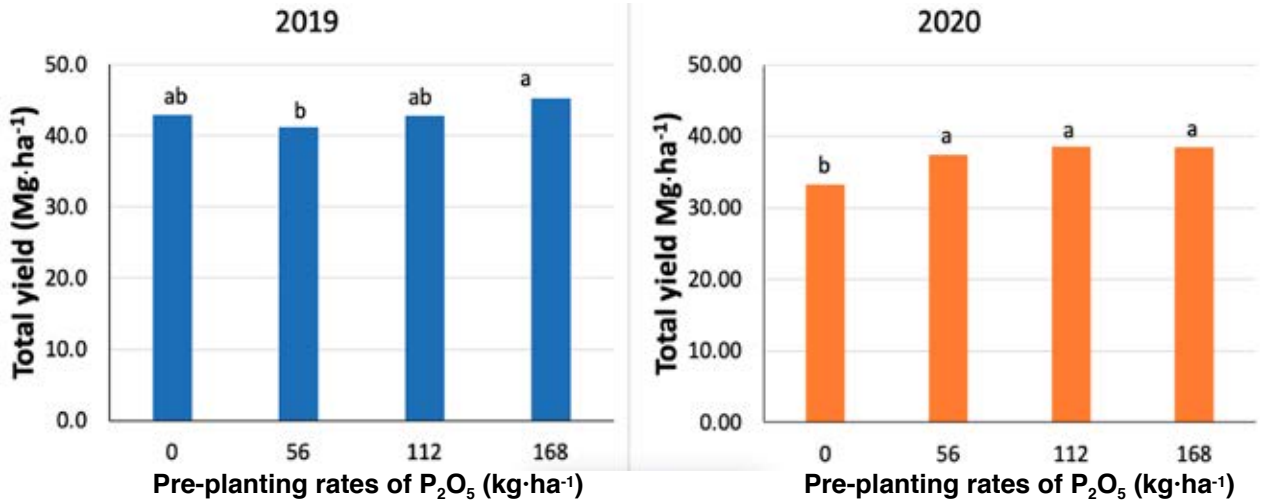

Fig. 1. Main effect of pre-planting (P_{pp}) application rates on potato yield cultivated in Hastings, FL in 2019 and 2020. Mean values followed by different lowercase letters denote significant differences at $P < 0.05$ according to Tukey test.

Table 2. Effect of liquid P-fertilization applied at emergence (P_{eme}) and tuber initiation (P_{ini}) on total and marketable yield of potato cv. Atlantic cultivated in Hastings, FL in 2019 and 2020.

	Total yield (Mg·ha^{-1})		Marketable yield (Mg·ha^{-1})	
P-fertilizer rate	2019	2020	2019	2020
P_{eme} (kg·ha^{-1} P_2O_5)				
0	43.7	36.5	38.3	30.7
28	42.4	37.4	37.4	31.6
P_{ini} (kg·ha^{-1} P_2O_5)				
0	42.0 b[y]	37.8	36.9 b	31.9
28	44.2 a	36.1	38.8 a	30.4

[z]Mean values followed by different lowercase letters denote significant differences at $P < 0.05$ according to Tukey test. Absence of letters denotes means are nonsignificant.

The results from this study indicate that there has been an increase in both total and marketable tuber yield due to added P fertilizer applied at P_{pp}. Further investigation, based on field evaluation of tuber yield responses across the state and for multiple soils is required to improve interpretation of Mehlich-3 test result. The in-season liquid application at P_{ini} affected tuber yield, dry biomass accumulation, and P uptake in only one season. Therefore, it is likely that P availability was improved near the tuber initiation growth stage. Further verification of in-season liquid P application is required before becoming a recommended practice.