Impacts of P & K Fertilizers Blends on Arizona Alfalfa Hay Yield

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THE UNIVERSITY OF ARIZONA
Cooperative Extension
Field Crops

Alfalfa, *Medicago sativa:* Importance

U.S.A (USDA's NASS, 2018):

- Harvested acres 16.60 millions
- Production 52.6 million tons
- Average yield 3.2 tons/acre
- Average price, $175 per ton
- Valued at over $9.2 billion,

Arizona (USDA's NASS, 2018):

- Harvested acres 260,000 (1.6%)
- Production 2.16 million tons (~13%)
- Average yield 8.3 tons/acre (>62%)
- Price per ton $209
- Valued at over $451 million

Production and productivity

- Main variety, non-dormant in fall,
- Multiple harvests per year,
- High productivity,
- Cutting cycle,
- Alfalfa stand life,
- Intensive production system,
- Aging associated problems,
- Require replacement,

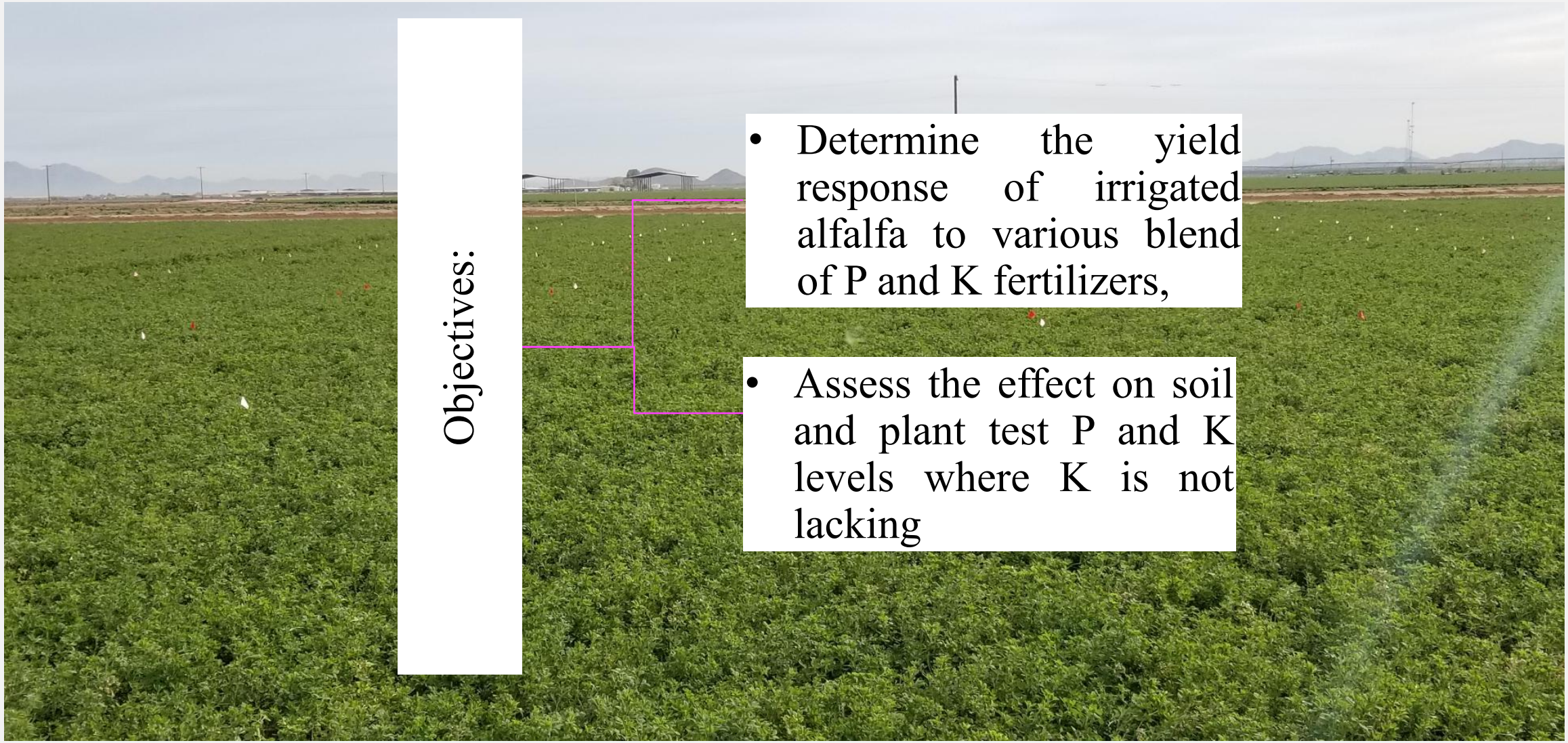
- Production continuity.
- 6 to 10 cuttings a year.
- Average of 8.4 tons/acre.
- 28 to 32 days schedule.
- > 3 years.
- Remove various resources.
- Affect yield, quality, autotoxicity.
- High establishment cost.

Pressing Issue

- Alfalfa stand loss (stand longevity issue),
- Yield reduction issue,
- Costly stand re-establishment,
- Excessive use of phosphorus & other resources,
- Increment in Cost of fertilizer,
- Environmental issue Vs. Growers interest (Market value)

Make it crucial to conduct study on balanced fertilizer management.

Objectives



Objectives:

- Determine the yield response of irrigated alfalfa to various blend of P and K fertilizers,
- Assess the effect on soil and plant test P and K levels where K is not lacking

Materials and Methods (MAC)

Sources of fertilizers:

- MAP (11-52-0)
- KCL (0-0-60)

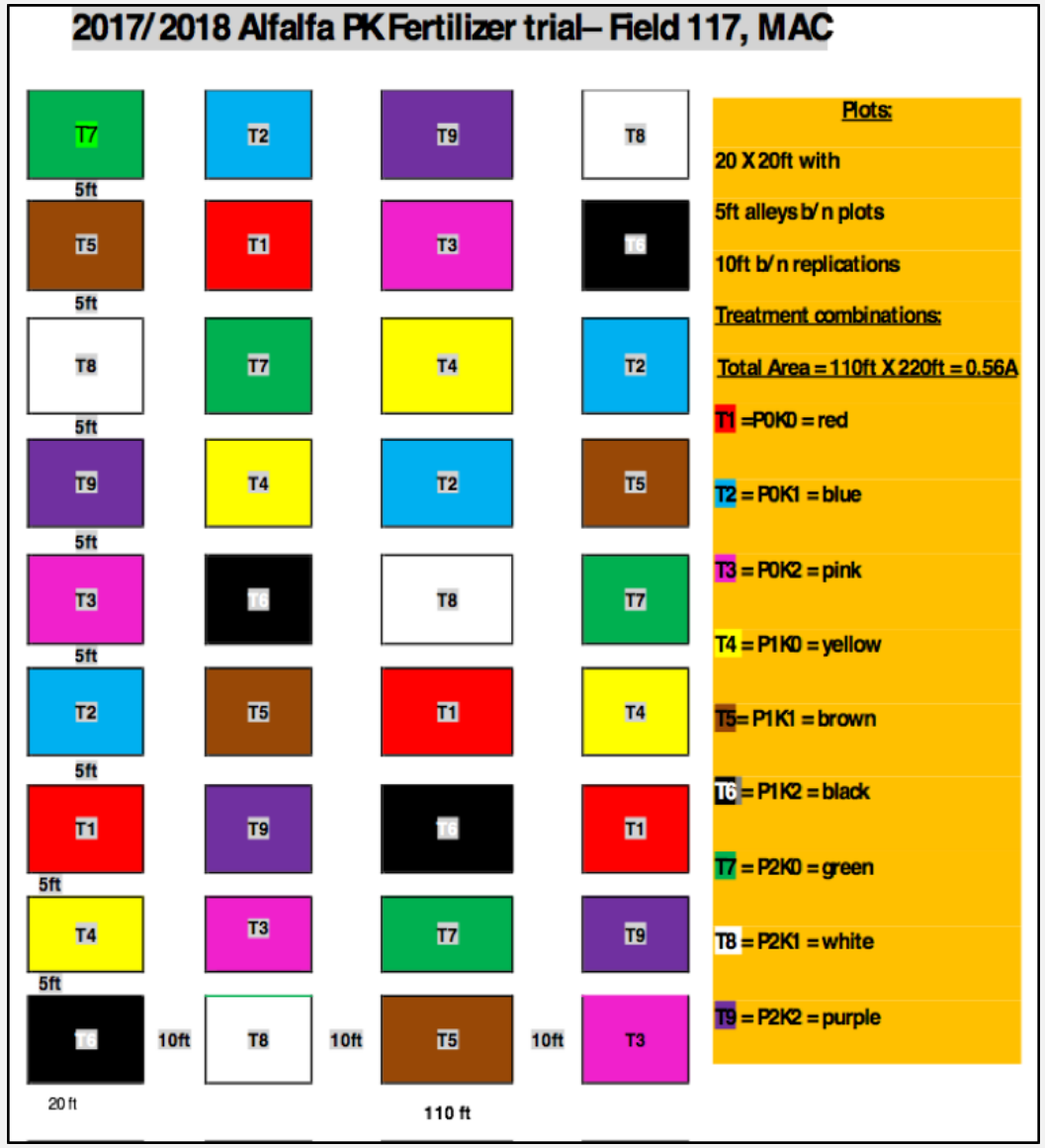
Rates (lb acre^{-1})

- MAP (0, 192, 240); P_2O_5 (0, 100, 125)
- KCL (0, 167, 500); K_2O (0, 100, 300)

Design: **Factorial in RCBD. Plot area = 400 ft^2 , 5 ft b/n plots and 10 ft b/n replications.**

Soil Analysis:

- Texture Sandy Clay loam
- K (ppm): 320
- Na (ppm): 250
- Olsen-P (ppm): 6.6
- Nitrate-N (ppm): 1.1
- pH: 8.2



Procedures

Fertilizers applied, November 2017,

Eight cuttings in 2018 and six in 2019,

Hay Yield adjusted to 12% moisture,

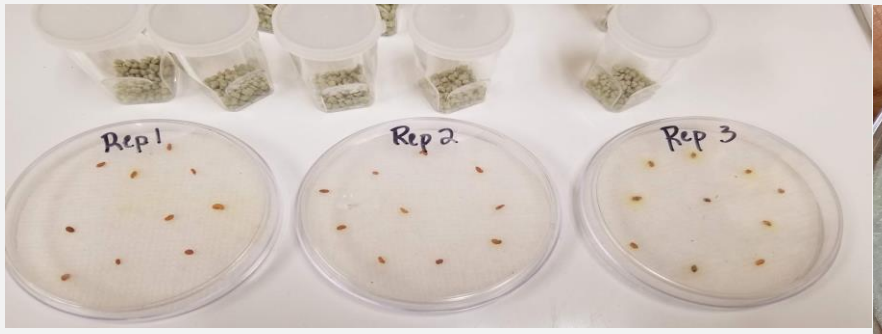
Soil samples at 6 inches depth collected,

Soil P & K determined

A subsample of 48 shoots each plot,

Plant P & K concentration determined

2019 Fertilizer Trial (Tube Trial)



Texture: Sandy loam	(72% sand)
K (ppm):	250
Na (ppm):	210
Olsen-p (ppm):	7.8
Nitrate-N (ppm):	3.9
pH:	9.0

Hay Yield (ton. acre^{-1})

P Fertilizer Increased Yield (2018)

Table 1. Influence of P fertilization on alfalfa hay yield at MAC, Arizona.

P_2O_5 (MAP)†	January	March	April	May	June	July	August	September	Total
Lbs. acre^{-1}	Hay Yield, tons acre^{-1}								
0 (0)	1.24B††	1.62B	1.94B	2.36B	2.69A	1.63B	2.15A	2.19B	15.82B
100 (192)	1.31B	1.85A	2.08A	2.49A	2.97A	1.93A	2.24A	2.33A	17.20A
125 (240)	1.46A	1.88A	2.10A	2.50A	2.88A	1.76AB	2.33A	2.31A	17.22A

† Sources of fertilizer: MAP-monoammonium phosphate (11-52-0).
†† Within a column, values followed by the same letters are not significantly different at 0.05 level of probability.

The benefit of phosphorus fertilizer was realized in all cuttings. No difference was detected between the rates of 100 (192) and 125 (240) lbs. acre^{-1}, after the first January cuttings.

P Fertilizer Increased Yield (2019)

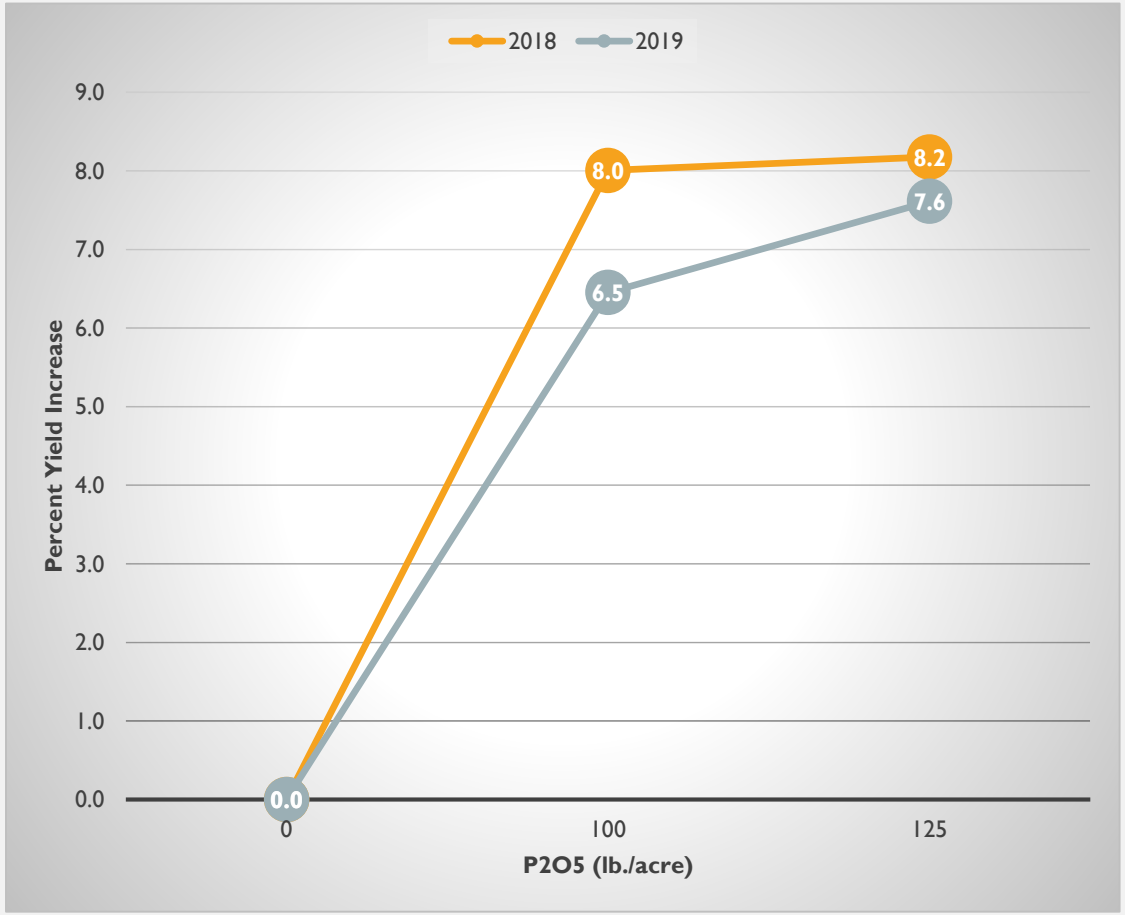
Table 2. P fertilization effect on alfalfa yield at MAC, Arizona.

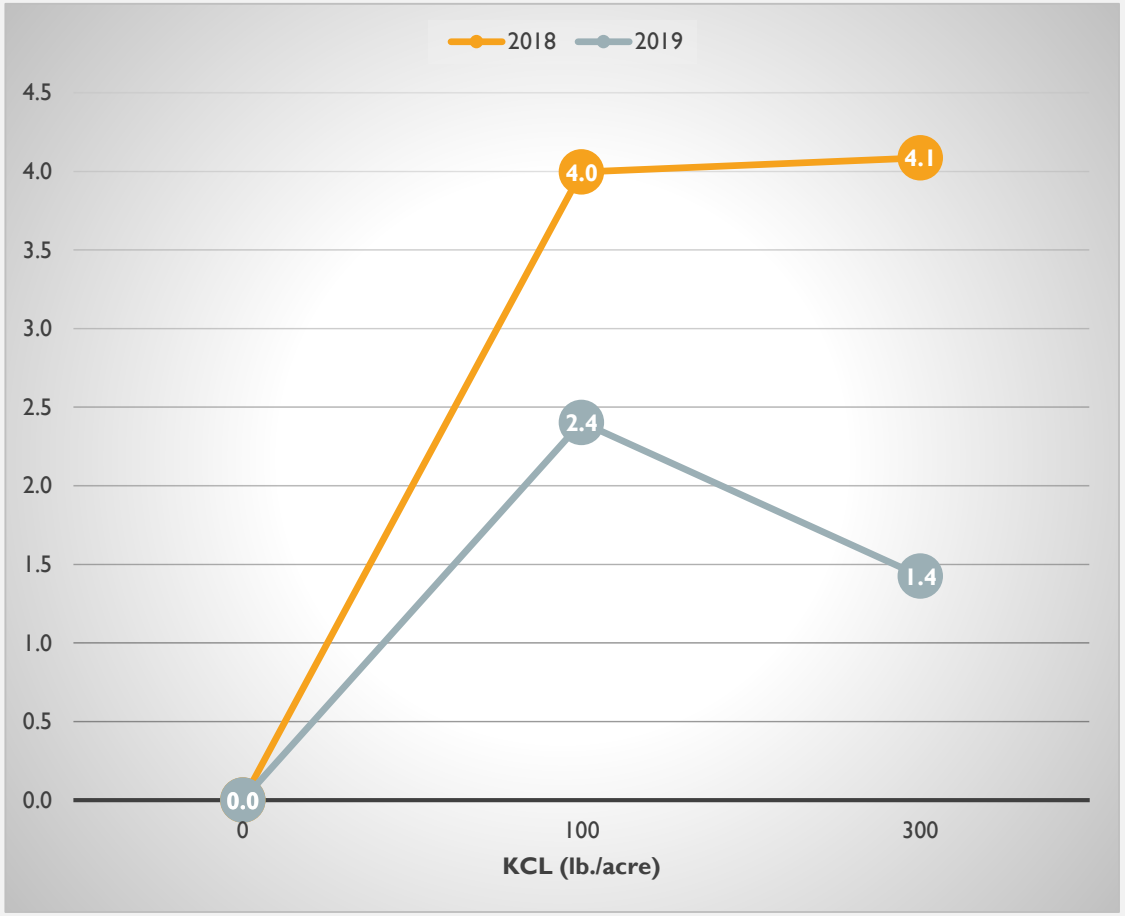
P_2O_5 (MAP)†	March	April	May	June	July	Aug	Total
Lbs. acre^{-1}	Hay Yield, tons ha^{-1}						
0 (0)	1.51B††	2.22A	2.18A	1.85A	1.67B	1.54A	10.98B
100 (192)	1.74A	2.32A	2.30A	1.89A	1.88A	1.61A	11.74A
125 (240)	1.83A	2.36A	2.32A	1.89A	1.85A	1.64A	11.88A

† Sources of fertilizer: MAP-monoammonium phosphate (11-52-0).
†† Within a column, values followed by the same letters are not significantly different at 0.05 level of probability.

The benefit of phosphorus fertilizer was realized in all cuttings. No difference was detected between the rates of 100 (192) and 125 (240) lbs. acre^{-1}

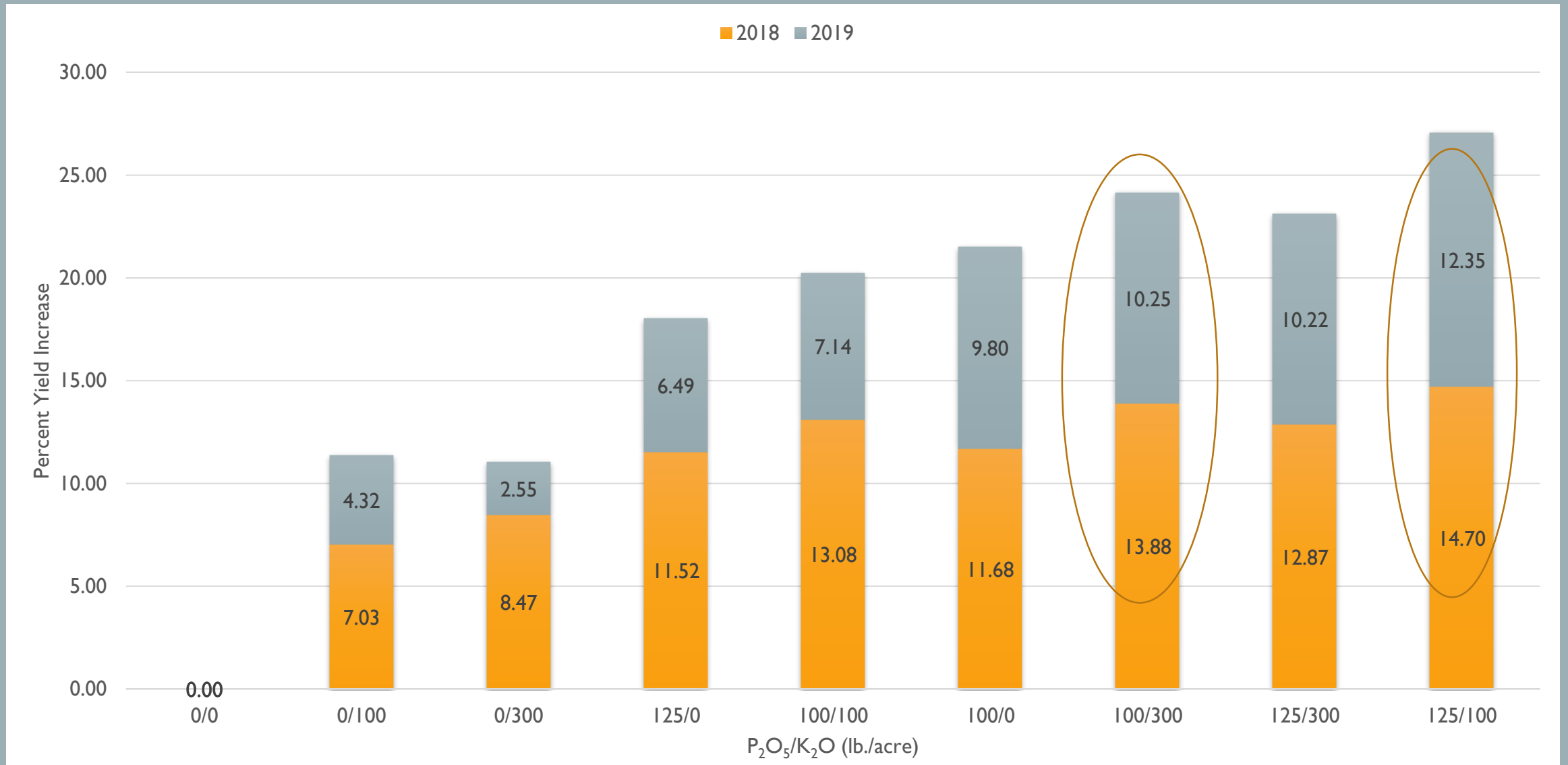
Individually P and K increased yield (MAC)





Individually, percent yield increase ranged from 8 to 8.2% in 2018 (8 cuttings), 6.5 to 7.6% in 2019 (6 cuttings) for Phosphorus. It ranged 4.0 to 4.1% in 2018, and 1.4 to 2.4% in 2019 for potassium.

A P-K Combination effect on yield at MAC (2018 & 2019)



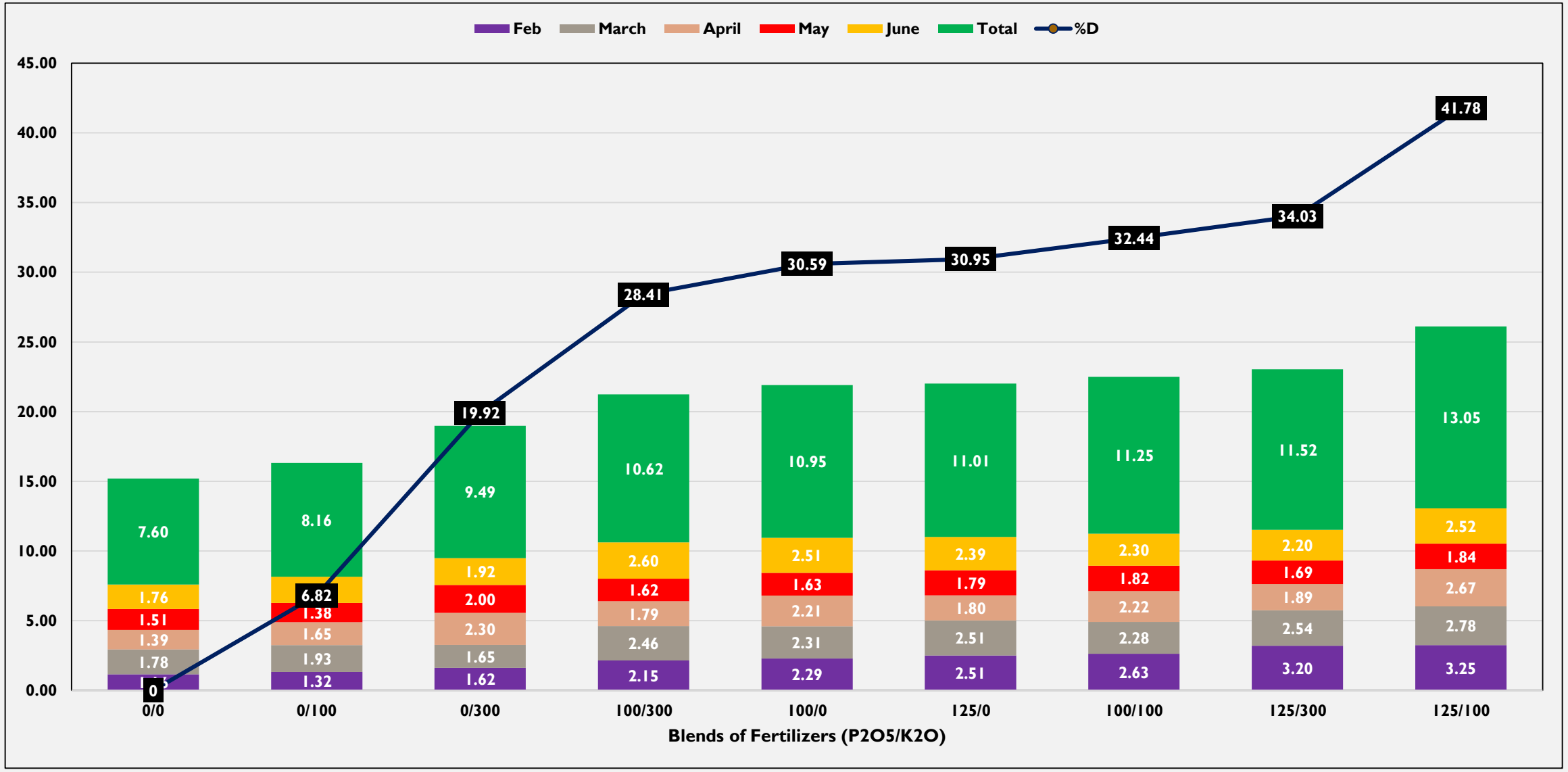
Percent yield increase due to P & K treatments over untreated control ranged from **7.03** to **14.70**% in **2018 and 2.55** to **12.35** in **2019.**

Balanced Fertility Synergetic Effect at MAC (average of 2018 & 2019)

P_2O_5 (lb. acre^{-1})	K_2O (lb. acre^{-1})	Yield (tons ac^{-1})	Response
0	0	12.86	--
0	100	13.66	0.80, tons ac^{-1}
125	0	14.20	1.34, tons ac^{-1}
125	100	14.90	2.04, tons ac^{-1}
Average (P + K)		13.94	1.08, tons ac^{-1}
Difference {(PK- ave (P+K)}		0.96	**6.44%**
Yield Advantage of Interaction (PK) over Individual components			
Together (PK) over P alone		0.7 (4.70 %)	Synergetic effect of PK Interaction
Together (PK) over K alone		1.24 (8.32 %)	

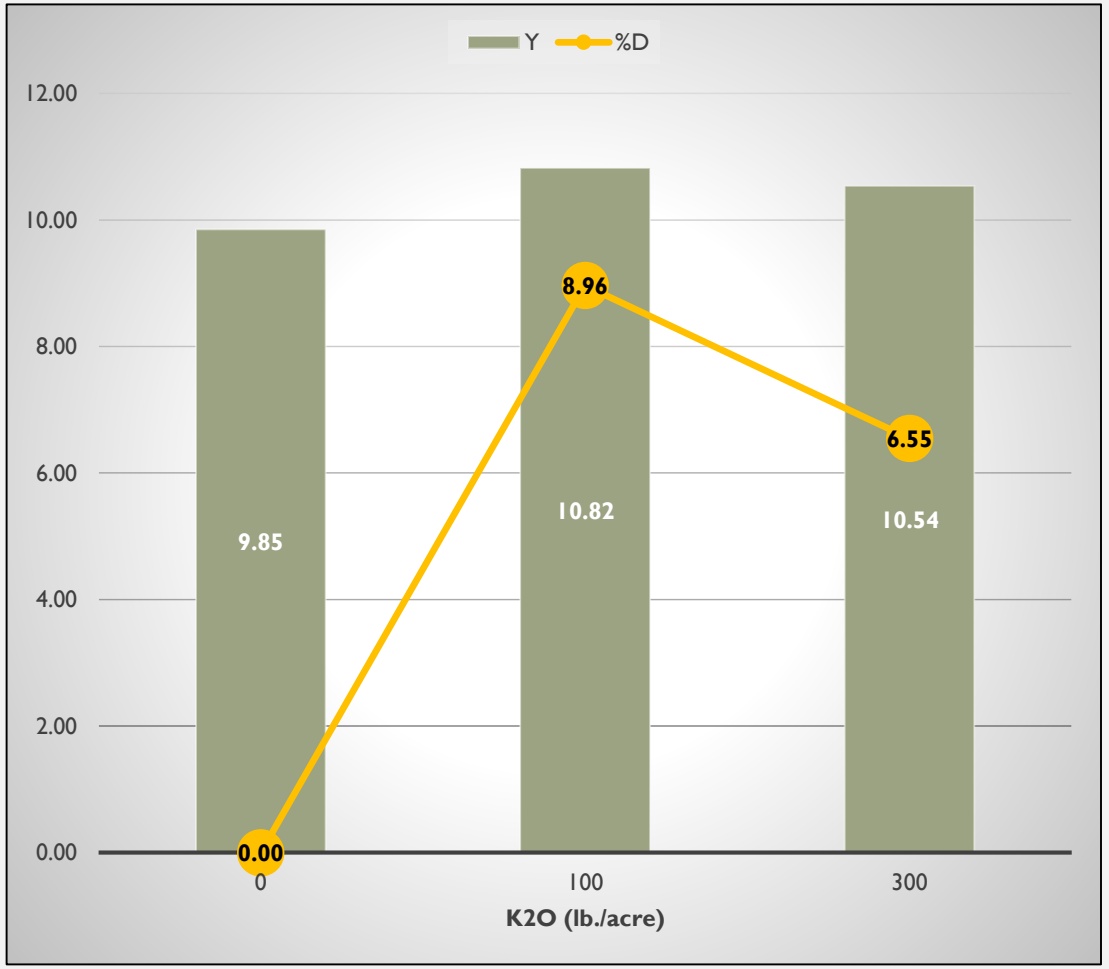
P and K together increased hay yield by 2.04 tons ac^{-1} over unfertilized, and 0.7 tons ac^{-1} (5%) over P alone and 1.24 tons ac^{-1} (8.32%) over K alone or an increase of 0.96 tons ac^{-1} (6.44%) more (synergetic effect) than when average of each was applied alone.

A P-K Combination effect on yield (5 Cuttings Tube-2019)



Percent yield increase (%D) due to P & K treatments over untreated control ranged from **6.82** to **41.78**% **in 2019 in the Tube trial.**

P AND K IMPACT ON YIELD (TUBE-2019)



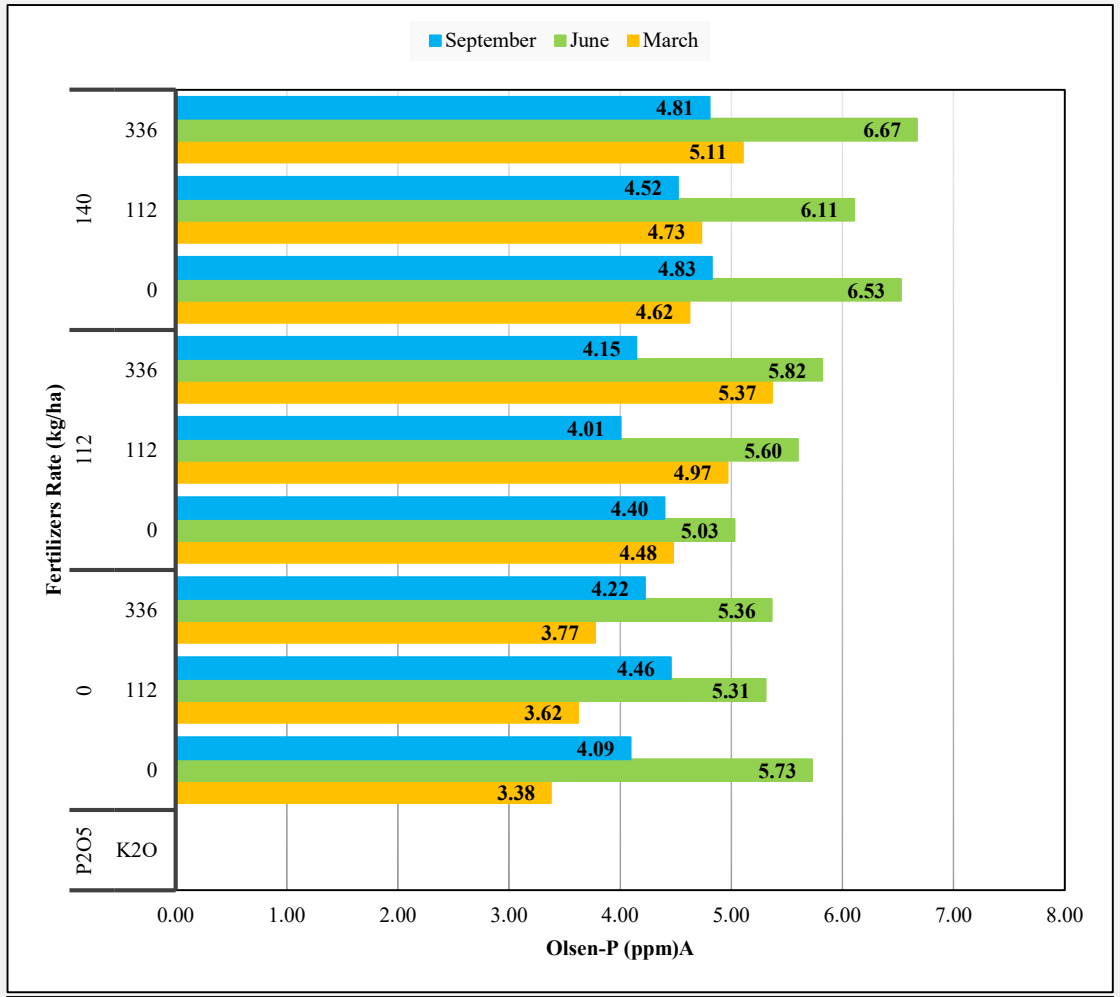
Individually, percent yield (Y) increase (%D) ranged from 23.03 to 29.01% for Phosphorus and ranged 6.55 to 8.96% for potassium in 2019 (5 cuttings).

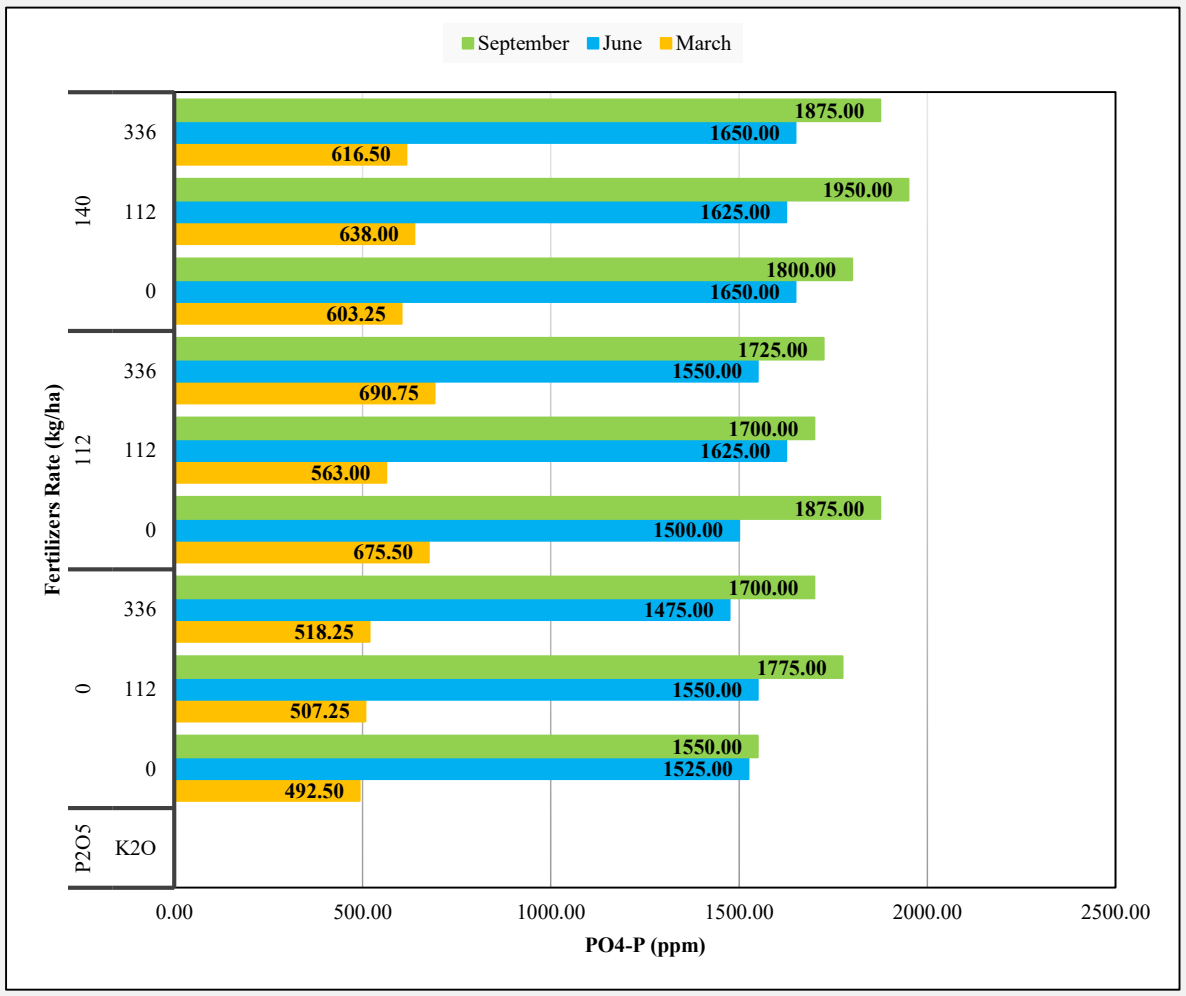
Balanced fertility synergetic effect (2019-Tube)

P_2O_5 (lb. acre^{-1})	K_2O (lb. acre^{-1})	Yield (tons acre^{-1})	Response
0	0	7.60	--
0	100	8.16	0.56, tons ac^{-1}
125	0	11.01	3.41, tons ac^{-1}
125	100	13.05	**5.45, tons ac^{-1}**
Average (P + K)		9.59	1.99, tons ac^{-1}
Difference {(PK-ave(P+K)}		3.46	**26.51%**
Yield Advantage of Interaction (PK) over Individual components			
Together (PK) over P alone		2.04 (15.63 %)	Synergetic effect of PK Interaction
Together (PK) over K alone		4.89 (37.47 %)	

P and K together increased hay yield by 5.45 tons/ac over unfertilized, and 2.04 (15.37%) over P and 4.89 (37.47%) tons/ac or an average increase of 26.51% more (synergetic effect) than when the average of both P and K applied alone.

Added Fertilizers Affected Soil and Plant phosphorus



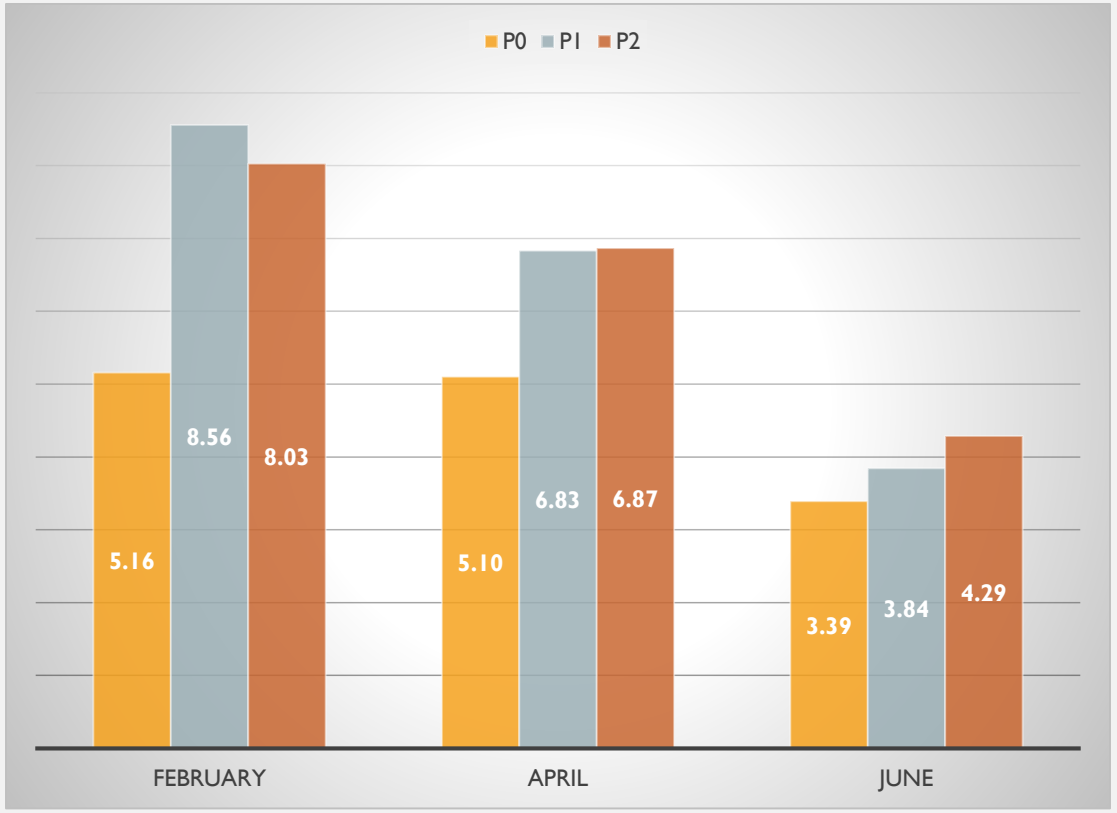


Olsen P ranges from 3.38 to 5.37 in March, 5.03 to 6.67 in June, and 4.01 to 4.83 ppm in September.

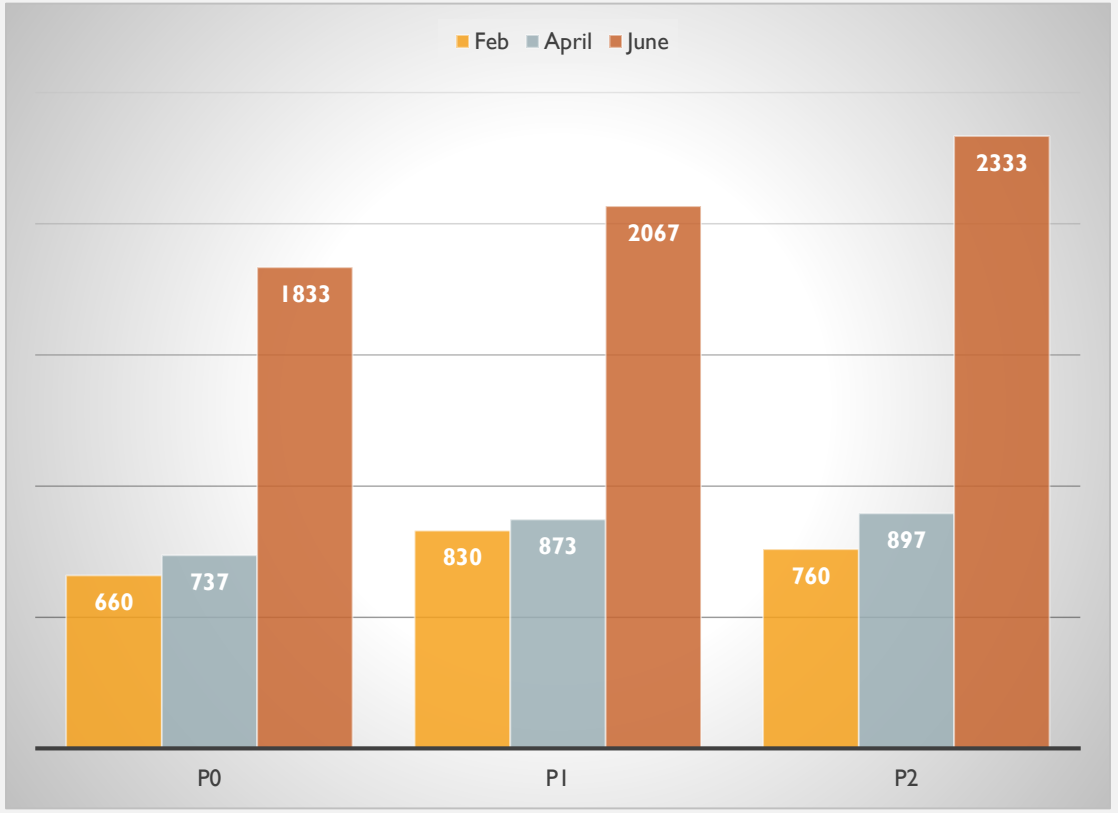
The PO4-P tissue levels < 700-ppm level in March, 1475 to 1650 ppm in June, and 1550 to 1950 ppm in September.

Phosphorus Fertilizer Effect on Soil and Plant-p (Tube-2019)

Olsen-p



Plant concentration (PO4-P)



Summary

- P has significant, while K has slight effect on yield individually,
- P & K interaction has synergetic effects on yield,
- Highest fertilizer application did not result in **significantly** increased yield,
- Balanced PK produced the highest productivity,
- With increasing fertilizer costs, a conservative approach to identifying fertilizer application rates may be more profitable.
- Additional research and detail economic analysis required.

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