IMPROVING ALFALFA HAY YIELD WITH APPLICATION OF BALANCED P & K FERTILIZERS

Worku Burayu and Ayman Mostafa

The university of Arizona, Cooperative Extension

Field Crops "Clinics" (Virtual)

Wednesday, January 27, 2021 – 10:00 AM – 2:30 PM

THE UNIVERSITY OF ARIZONA Cooperative Extension Field Crops

THE LOW DESERT ARIZONA

- Hot summers, warm winters, dry climate,
- Little to no precipitation
- Soils,
- N from N-fixing nodules.
- K is assumed to be abundantly available
- Low to medium Olsen-P
- Variety nondormant, Very N, Extremely N
- Intensive production system
- Frequent alfalfa harvesting, may lead to

- Enabling crop growth throughout the year.
- Fully irrigated, Surface flood irrigation.
- Alkaline and calcareous
- N fertilizer is generally not applied.
- K not typically applied to crops.
- Phosphate fertilizer commonly applied.
- fall dormancy class 8, 9, 10.
- Average of 8.4 tons/acre (6 to 10 cutting).
- Reduction in yield and stand persistence

Figure 3: K deficiency symptoms on alfalfa leaves. (Ludwick, 2012)

PRESSING ISSUE

Stand longevity issue,
Yield, quality, autotoxicity issues,
Excessive use of single nutrient, salts
Costly stand re-establishment,
Increment in Cost of fertilizers,
Environmental issue Vs. Growers interest,
No or limited information on balanced nutrients

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

METHODOLOGIES (MAC & TUBE)

Sources of fertilizers:

MAP (11-52-0)

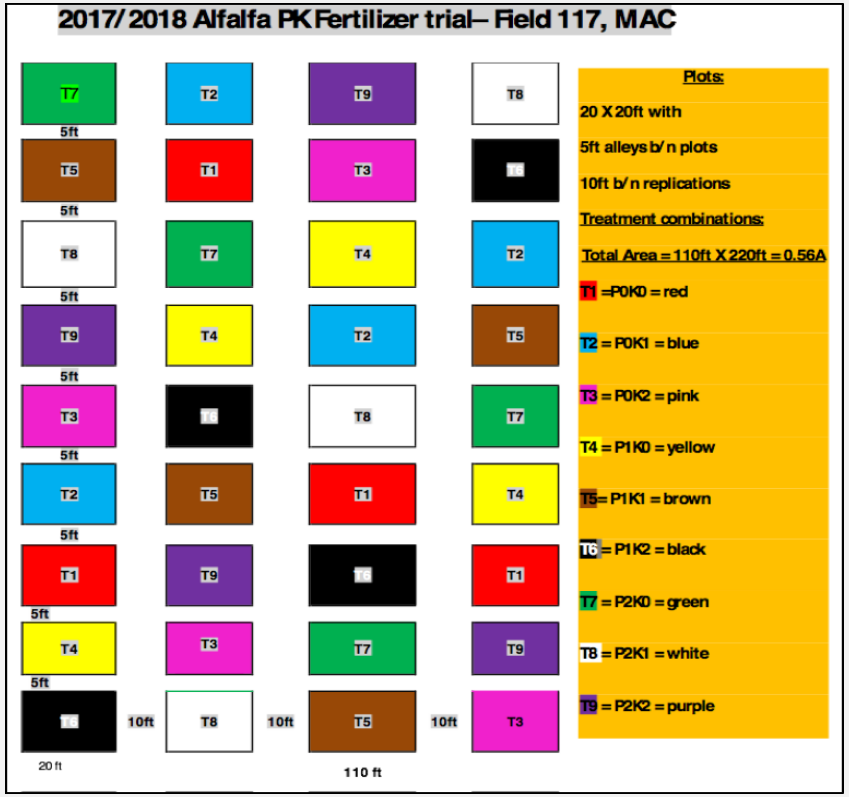
KCL (0-0-60)

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.



Soil Standard Test	Method	MAC	Tube	Units	Levels
pH	1:1	8.2	9	SU	H
Potassium (K)	NH4OAc (pH8.5)	320	250	ppm	H
Nitrate-N (No_3-N)	cd-Reduction	1.1	3.9	ppm	L
Phosphate-P (Po_4-P)	Olsen	6.4	7.8	ppm	M
Sand	Hydrometer	58	72	%	
Classification	Hydrometer	SCL	SL		

Methodologies (Cont.)

- Eight cuttings in 2018 and six in 2019 (MAC),
- Six cuttings in 2019 & five times in 2020 (TUBE)
- 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

RESULTS

Table 1. Hay yield under the influence of three P fertilization rates on sandy clay loam soil, in 2018 and 2019 at MAC. The data were averaged over three K fertilization rates and four replicates.

P_2O_5 (MAP)†	January	March	April	May	June	July	August	September	Total
Lbs. acre^{-1}	2018 (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
Average	1.34	1.78	2.04	2.45	2.85	1.78	2.24	2.27	16.75

P_2O_5 (MAP)†	March	April	May	June	July	Aug	Total
Lbs. acre^{-1}	2019 (Hay Yield, tons acre^{-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
Average	1.69	2.30	2.27	1.88	1.8	1.60	11.53

†† Within a column in the same year, values followed by the same letter are not significantly different at 0.05 level of probability (Student's t-test).

Table 2. Hay yield under the influence of three P fertilization rates on sandy loam soil, in 2019 and 2020. The data were averaged over three K fertilization rates and three replicates.

P_2O_5†	February	March	April	May	June	July	Total
lb acre^{-1}	**2019 Hay Yield, t a^{-1}**						
0	1.37C	1.79B	1.78A	1.63A	1.86B	0.91A	9.32B
100	2.36B	2.41A	2.04A	1.75A	2.41A	1.12A	12.08A
125	3.01A	2.72A	1.99A	1.67A	2.35A	1.01A	12.75A
P_2O_5†	Dec	Feb	Apr	May	June		Total
lb acre^{-1}	**2020 Hay Yield, t a^{-1}**						
0	1.25B	1.97B	4.17B	2.77B	1.01B		11.17B
100	1.69A	2.59A	5.71AB	3.62AB	1.40A		15.02A
125	1.85A	2.91A	6.84A	4.42A	1.53A		17.55A

†† Within a column in the same year, values followed by the same letter are not significantly different at 0.05 level of probability (Student's t-test).

Table 3. Alfalfa hay yield as affected by various combinations of p and k fertilization rates during two growing seasons (2018 & 2019) on a sandy clay loam at mac. data are the means of four replicates

P_2O_5	K_20	2018	2019	Average
lb acre^{-1} yr^{-1}		t acre^{-1}		
0	0	14.98c†	10.72c	12.85c
0	100	16.11bc	11.21bc	13.66bc
0	300	16.37abc	11.00bc	13.69bc
100	0	16.96ab	11.96ab	14.46ab
100	100	17.24ab	11.55abc	14.40ab
100	300	17.40ab	11.69ab	14.55ab
125	0	16.93ab	11.46abc	14.20ab
125	100	17.56a	12.23a	14.90a
125	300	17.20ab	11.94ab	14.57ab

† Within a column in the same year, values followed by the same letter are not significantly different at 0.05 level of probability (Student's t-test).

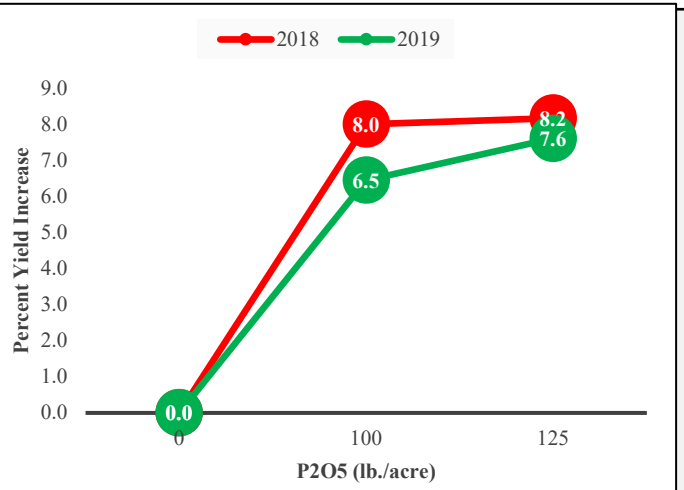
THE UNIVERSITY OF ARIZONA
Cooperative Extension
Field Crops

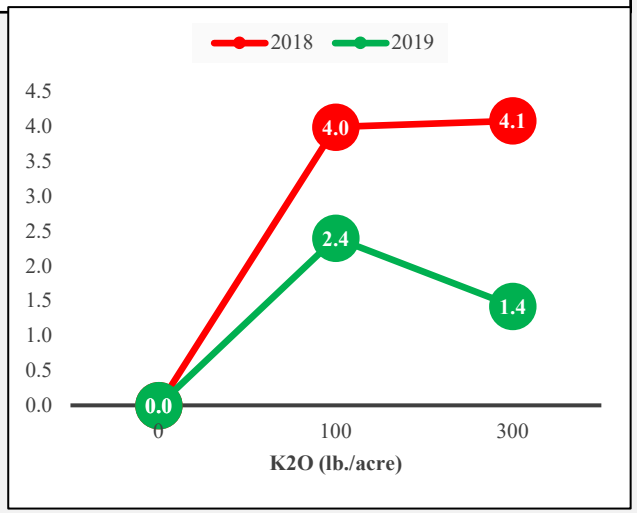
Table 4. Alfalfa hay yield as affected by various combinations of P and K fertilization rates during two growing seasons (2019 & 2020) on a sandy loam soil. Data are the means of three replicates.

P_2O_5	K_20	2019	2020	Average
lb acre^{-1} yr^{-1}		t acre^{-1}		
0	0	8.75c	11.17d	9.96d
0	100	8.82bc	11.72d	10.27d
0	300	10.40bc	10.61d	10.51d
100	0	12.17ab	13.05cd	12.61c
100	100	13.33ab	14.13abcd	13.73bc
100	300	11.31ab	18.42ab	14.86ab
125	0	12.09ab	16.87abc	14.48b
125	100	13.42a	20.58a	17.00a
125	300	13.07ab	15.55bcd	14.31bc

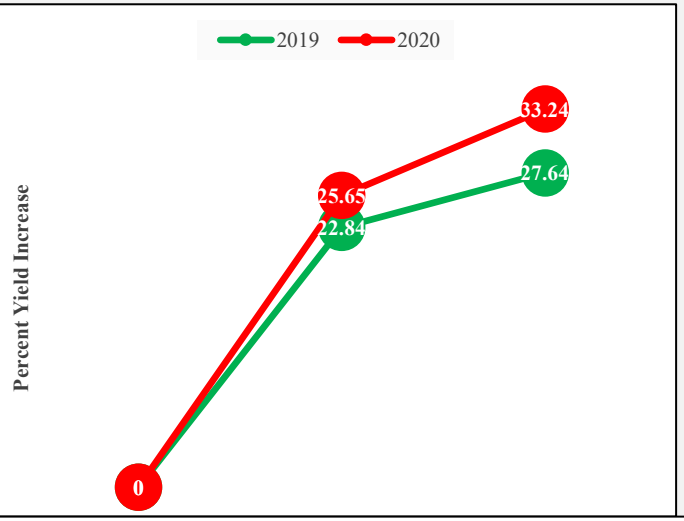
† Within a column in the same year and average of the year, values followed by the same letter are not significantly different at 0.05 level of probability (Student's t-test).

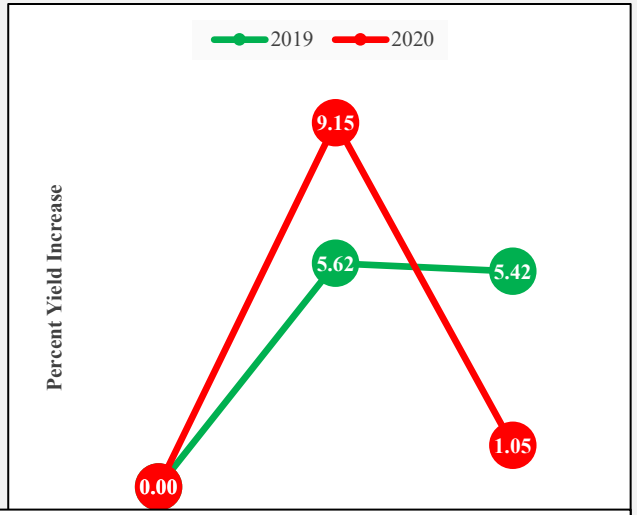
Individually P and K increased yield (MAC & Tube)





MAC

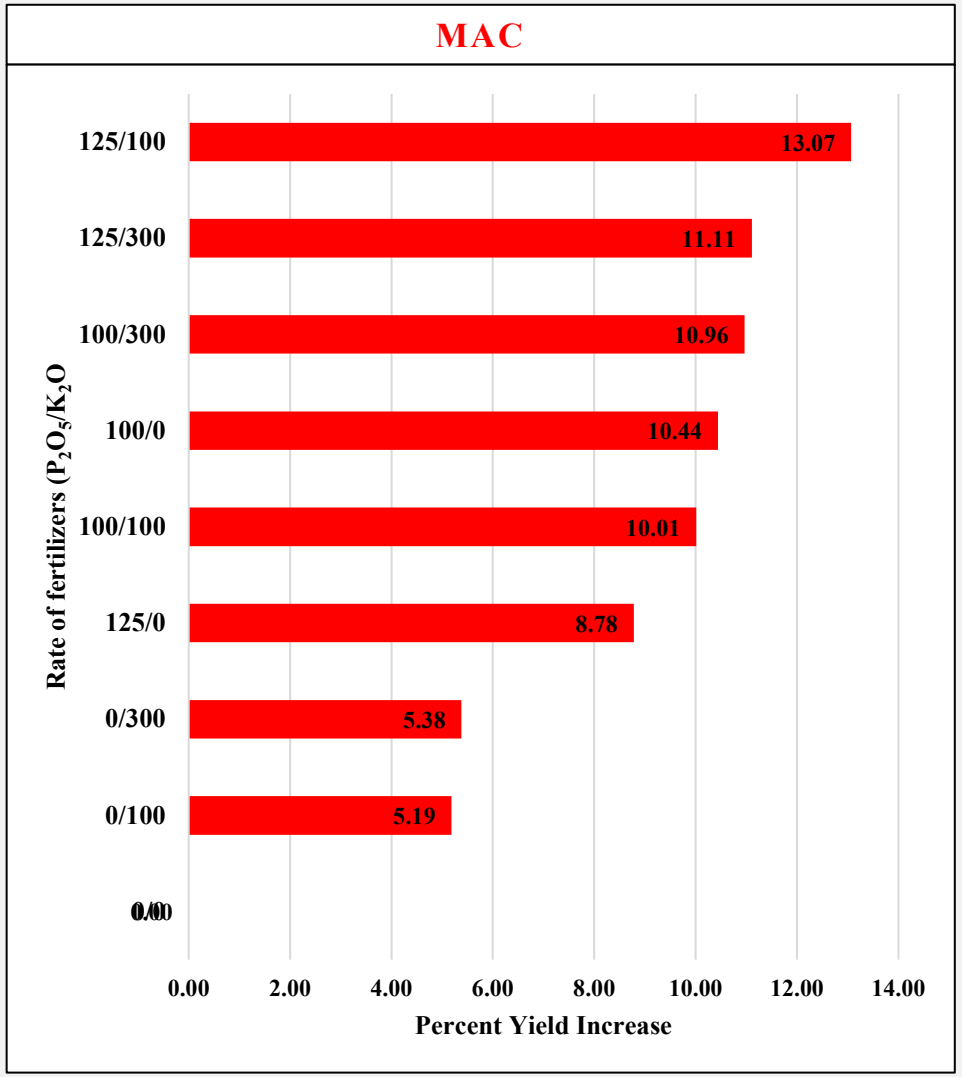


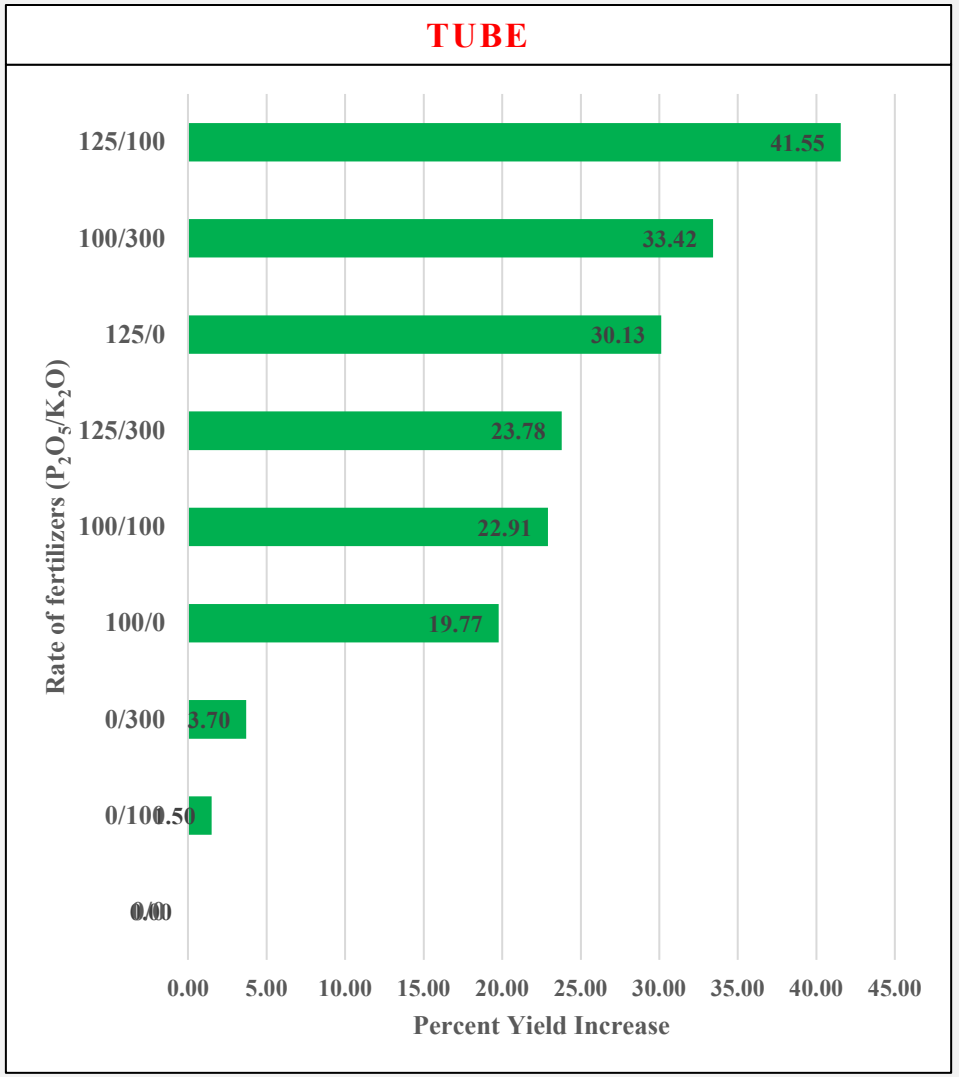


TUBE

THE UNIVERSITY OF ARIZONA
Cooperative Extension
Field Crops

Combination of P and K Increased Yield(average of two years)





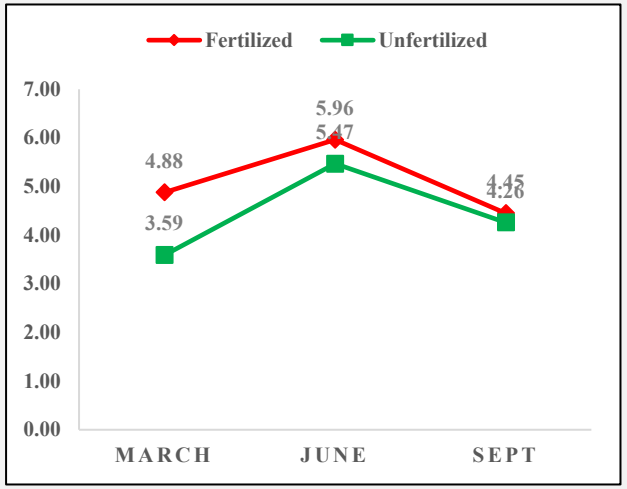
THE UNIVERSITY OF ARIZONA
Cooperative Extension
Field Crops

BALANCED FERTILITY SYNERGETIC EFFECT (AVERAGE OF TWO YEARS)

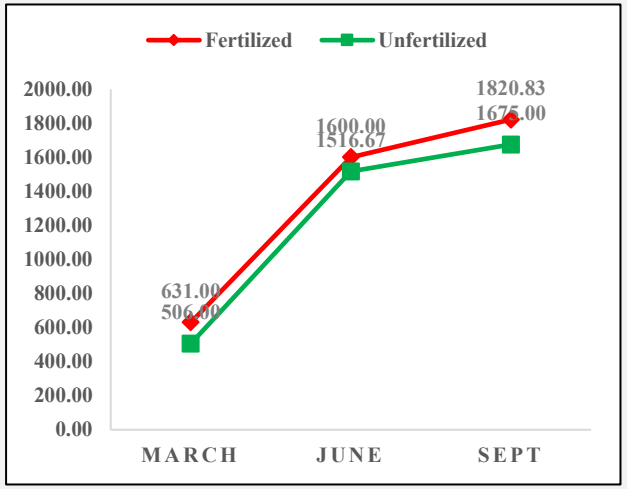
Percent Yield Increase						
	MAC			TUBE		
Yield Advantage	**2018**	**2019**	**Average**	**2019**	**2020**	**Average**
PK over Unfertilized (PK > No)	14.77	12.35	13.50	34.80	35.83	35.32
PK over K alone (PK > K)	8.30	8.42	8.35	34.29	40.76	37.53
PK over P alone (PK > P)	3.60	6.21	4.95	9.92	11.29	10.61
PK over aver (P + K) {PK > (P+K)/2)}	5.92	**7.28**	6.60	22.11	**26.02**	24.07

P & K fertilizers effect on Olsen-P and PO4-P

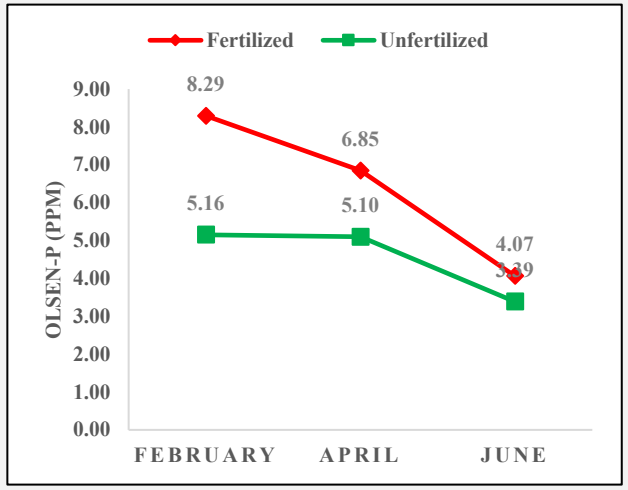
SOIL



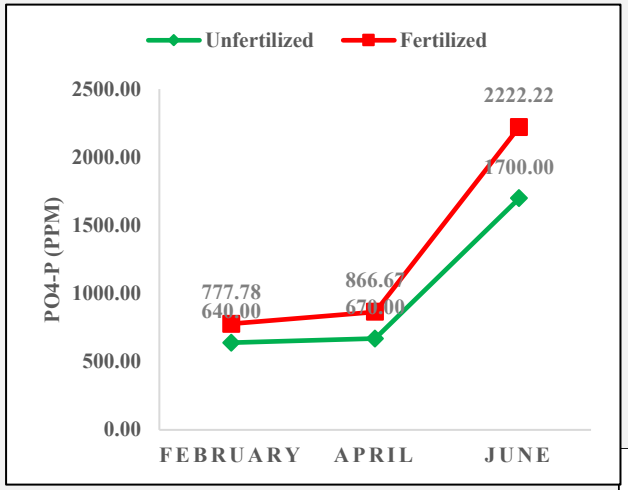
PLANT



MAC



TUBE



THE UNIVERSITY OF ARIZONA
Cooperative Extension
Field Crops

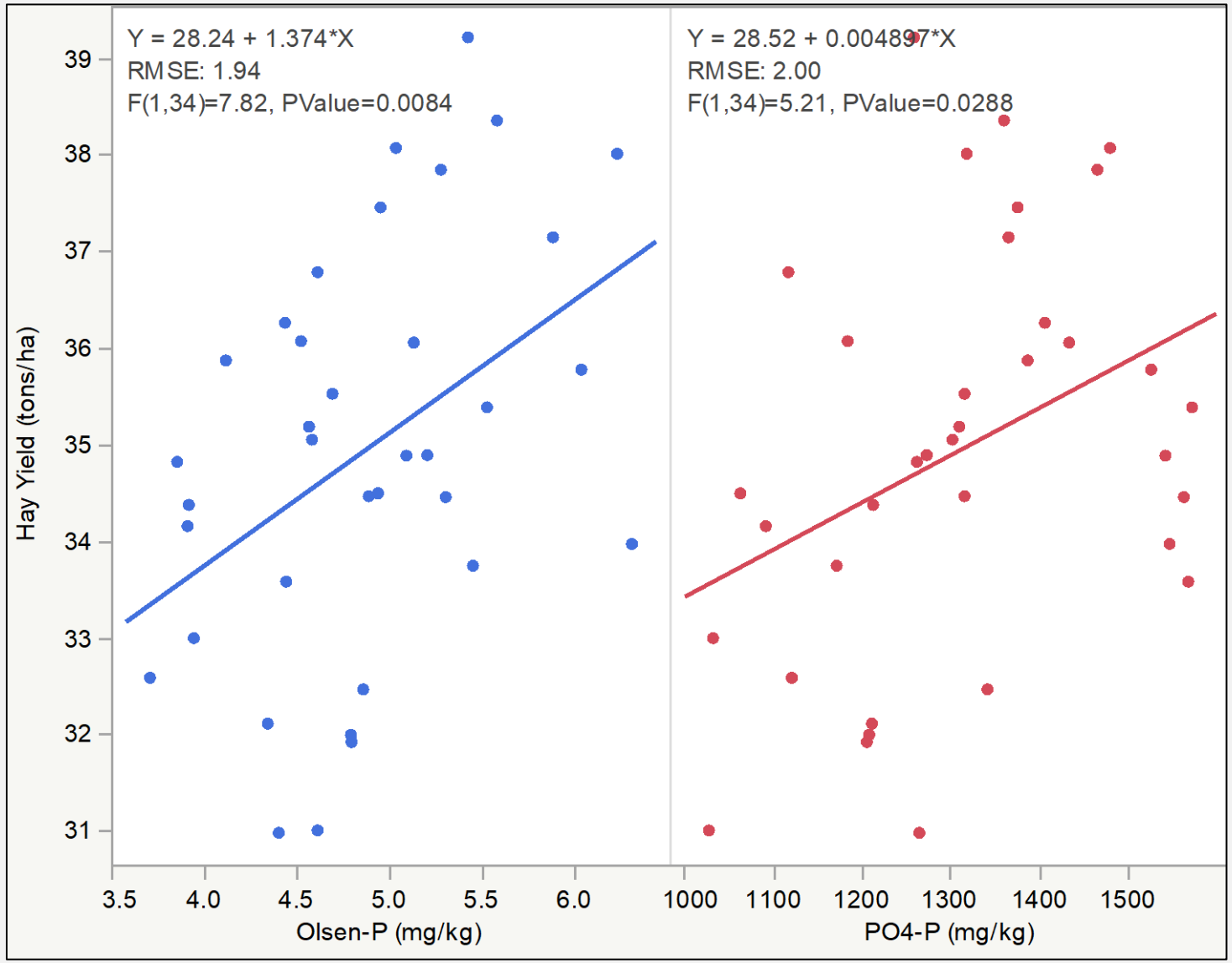


Figure. Olsen-P and plant-P (PO4-P) significantly and positively impacted Alfalfa hay yield.

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.

References

1. Barbarick, K.A. 1985. Potassium fertilization of alfalfa on a soil high in potassium. Agron. J. 77:442–445.
2. Berg, W.K., S.M. Cunningham, S.M. Brouder, B.C. Joern, K.D. Johnson, J. Santini, and J.J. Volenec. 2007. The long-term impact of phosphorous and potassium fertilization on alfalfa yield and yield components. Crop Sci. 47:2198– 2209.
3. Burayu, W., M. J. Ottman, and A.M. Mostafa 2016. Phosphorus fertilizer sources and rates effect on irrigated alfalfa in Arizona. Resilience Emerging from Scarcity and Abundance. 2016 ASA, CSSA and SSSA International Annual Meetings. https://scisoc.confex.com/crops/2016am/webprogram/Paper99961.html
4. Lissbrant, S., S.M. Brouder, S.M. Cunninghm, and J.J. Volenec. 2010. Identification of fertility regimes that enhance long-term productivity of alfalfa using cluster analysis. Agron. J. 102:580–591.
5. Mostafa, A., and W. Burayu. 2020. Improving Alfalfa Yield with Application of Balanced Fertilizers. University of Arizona Cooperative Extension Service and Agricultural Experiment Station Bulletin AZ1833-2020. https://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az1833-2020.pdf
6. M. Brouder, B. C. Joern, K. D. Johnson, J. Santini, and J.J. Volenec. 2005. Influence of phosphorus and potassium on alfalfa yield and yield components. Crop Sci. 45: 297-304.
7. Ottman, M.J., J. Rovey, A.M. Mostafa, and W. Burayu. 2015. Phosphorus fertilizer rate effect on alfalfa yield and soil test P, Buckeye, AZ 2014. University of Arizona Cooperative Extension Service and Agricultural Experiment Station Bulletin AZ1672-2015. https://extension.arizona.edu/sites/extension.arizona.edu/files/pubs /az1672-2015.pdf


THANK YOU!!