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# The Influence of Aging of P Fertilizer and Rainfall on the Yield and P Uptake by *Setaria*

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## ABSTRAK

*Satu kajian untuk meneliti pengaruh jangka masa pembajaan, bentuk, paras baja fosforus (P) dan hujan terhadap hasil dan pengambilan P oleh rumput pastura* Setaria splendida *pada tanah Siri Bungor telah dilakukan. Didapati paras rawatan baja P memberi pengaruh yang lebih daripada jangka masa rawatan dan bentuk P yang digunakan terhadap hasil berat kering dan pengambilan P oleh* Setaria. *Perbezaan hujan semasa pertumbuhan* Setaria *dapat membawa kepada perbezaan sebanyak 39% hasil berat kering dan 20% pengambilan P.*

## ABSTRACT

*An experiment to look into the influence of aging of phosphorus (P) fertilizer, P forms, P levels and rainfall on the yield and P uptake by pasture grass* Setaria splendida *on a Bungor Series soil (Typic Paleudult) was carried out. It was concluded that P treatment levels have more influence than the aging and forms of P fertilizer used on the dry matter yield and P uptake by* Setaria. *Variations in rainfall during the growing period of* Setaria *could account for up to a difference of 39% in dry matter yield and 20% of the P taken up.*

## INTRODUCTION

Weather conditions under which crops are grown affect their yield. For this reason, we cannot compare yield of crops of similar treatments growing at different periods due to the different weather conditions the crops have been subjected to. Russel (1975) and Seif and Paderson (1978) concluded that 65 – 85% variation in crop yield can occur due to rainfall variability. Rainfall has been singled out as the main factor of weather affecting yield of crops in Malaysia (Nievwolt, 1978; Foster *et al.*, 1981). In this respect, the intensity and distribution of rainfall are important.

Fertilizer application either as rock phosphate or superphosphate forms are often given in excess to plants compared to the need resulting in an accumulation of P fertilizer (Ling and Mainstone, 1982). The accumulated P fertilizer or residual P does provide the P requirements of succeeding crops or to the present crop at later stages of growth.

A study comparing double superphosphate and rock phosphate in the field planted with rubber, a deep rooted plant showed that rock phosphate gave a higher residual effect (Pushparajah *et al.*, 1977). However, the residual performances of the P fertilizer in the course of time

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and its contribution towards the requirement of annual crops with a shallow root system has not been dealt with in depth under Malaysian field conditions. It is therefore the objective of this study to look into the influence of aging of P fertilizer and rainfall on the yield and P uptake by *Setaria* grass.

## MATERIALS AND METHODS

*Soil*

This study was carried out at the Universiti Pertanian Malaysia farm at Puchong which is about 15km from Serdang. The soil is Bungor Series, classified in soil taxonomy as Typic Paleudult. The physical and chemical characteristics are given in Table 1.

*Methodology*

In order to look at the effect of aging of P fertilizers on plant performance, the design of the experiment should exclude the influence of the variability of the weather on the plant parameters observed. This can be achieved by having a time interval between the fertilizer P applications. In our experiment the 'Aged P' plots were left bare until the 'Recent P' plots were treated. Planting of crops was done simultaneously on both P treated plots one year after the application of the 'Aged P' treatments. With this set up, differences in the plant parameters observed were due to the effect of P applications interval and P treatments only.

Having determined the influence of interval of P applications on the plant components, the influence of rainfall on those parameters could also be deduced. This is the difference in the plant performances between the harvests minus differences due to interval and P treatments.

*Experimental Layout*

A split plot field design consisting of four whole plots were used. It consisted of two intervals in fertilizer treatments (recent and aged P), three P levels (0, 150 and 300kg P/ha), two P sources (Rock phosphate (RP) and Triple superphosphate (TSP)) with four replicates. Each replicate of the treatments was randomly distributed within each whole plot (Details of the treatments are presented in Table 2). Each plot has a size of $8 \times 3$m. Plots receiving aged P treatments were fertilized a year earlier than the recent P fertilizer treated plots. Phosphate fertilizer was broadcasted and rotovated into the plough layer (20cm) using a pedestrian rotovator. *Setaria splendida* grass was planted by the use of 9cm long cuttings. Harvesting of *Setaria* was carried out every two months on a $6 \times 2$m area, fresh weight taken and a subsample of about 1kg was taken to the laboratory for dry matter weight determination. The subsample was grind, wet ashed and P determined by the use of the auto analyser (Aminuddin, 1985).

Rainfall data of the Puchong Farm was obtained from the weather station manned by the Soil Science Department, Universiti Pertanian Malaysia.

## RESULTS AND DISCUSSION

*Yield of **Setaria** Affected by Aging and P Treatments*

The one year difference in the time of fertilizer P application did not affect the dry matter yield of *Setaria* (Table 3). The mean dry matter yield of the first harvest for the aged P plots was 1.6 tons/ha while the recent P application resulted

TABLE 1
The physical and chemical characteristics of the Bungor soil at the Puchong Farm

| pH($H_2O$) | %N | %C | C.E.C. (meq/100g) | Bray 2P ($\mu$g P/g) | Total P ($\mu$g P/g) |
|---|---|---|---|---|---|
| 5.0 | .08 | 1.94 | 9.2 | 6.9 | 208 |

| Exchangable bases (meq/100g) | | | | Particle size distribution (%) | | |
|---|---|---|---|---|---|---|
| Na | K | Ca | Mg | clay | silt | sand |
| .15 | .32 | .73 | .36 | 48.7 | 16.4 | 34.9 |

TABLE 2

Fertilizer treatments

| Treatments | Rate (kg P/ha) | Per plot basis (kg fert./24 $m^2$) |
|---|---|---|
| Control | 0 (PO) | 0 |
| TSP (19.04%P) | 150 (S1) | 1.89 |
| | 300 (S2) | 3.78 |
| RP (13.55%P) | 150 (R1) | 2.66 |
| | 300 (R2) | 5.32 |

TABLE 3

P application interval on dry matter yield

| Harvet No. | Interval | $P_o$ | $R_1$ | $S_1$ | $R_2$ | $S_2$ |
|---|---|---|---|---|---|---|
| | | | | tons per ha | | |
| 1 | Aged P(A) | 1.03 | 1.85 | 1.45 | 1.74 | 1.94 |
| | Recent (R) | 1.16 | 1.63 | 1.69 | 1.76 | 1.66 |
| | Mean | 1.10[a] | 1.74[b] | 1.57[b] | 1.75[b] | 1.80[b] |
| 2 | A | 1.00 | 1.81 | 1.47 | 1.45 | 1.37 |
| | R | 1.01 | 1.76 | 1.29 | 1.80 | 1.05 |
| | Mean | 1.00[a] | 1.79[c] | 1.38[abc] | 1.62[bc] | 1.21[ab] |
| 3 | A | 1.61 | 2.17 | 1.85 | 1.78 | 2.20 |
| | R | 1.45 | 2.49 | 2.00 | 1.99 | 1.92 |
| | Mean | 1.53[a] | 2.33[b] | 1.92[ab] | 1.88[ab] | 2.06[b] |
| 4 | A | 0.95 | 1.64 | 1.52 | 1.91 | 1.74 |
| | R | 0.88 | 1.86 | 1.65 | 1.65 | 1.76 |
| | Mean | 0.91[a] | 1.75[b] | 1.59[b] | 1.78[b] | 1.77[b] |
| 5 | A | 1.22 | 1.18 | 1.34 | 1.73 | 1.61 |
| | R | 0.99 | 1.39 | 1.67 | 2.00 | 1.89 |
| | Mean | 1.11[a] | 1.28[ab] | 1.50[bc] | 1.86[c] | 1.75[c] |

*For this and subsequent tables, means on the same row followed by the same superscript are not significantly different using DMRT at P = 0.05.

in 1.58 tons/ha. No differences in dry matter yield values were observed between the aged and recent applications in the second and subsequent harvests.

P treatment levels, however, affected the dry matter yield values. PO plots registered the lowest dry matter yield in all the harvests. This was significantly lower than the rest of the P treated plots. Plots treated with 150kg P did not differ in dry matter yield with that of 300kg P/ha. Sources of fertilizer P used either as RP or SP did not give differences in the results.

### *P Uptake Values Affected by Aging and P Treatments*

P uptake values of *Setaria* were not affected by the aging of the fertilizer P (Table 4). The one year difference in the time of P application did not result in a difference in P uptake at the different P treatment levels. This was recorded in all the five harvests. PO plots were significantly lower in P uptake values compared to the rest of the P treated plots. P treated plots were, however, not different from each other. Forms of P used did not influence P uptake by *Setaria*.

TABLE 4
P application interval on P uptake

| Harvet No. | Interval | $P_o$ | $R_1$ | $S_1$ | $R_2$ | $S_2$ |
|---|---|---|---|---|---|---|
| | | | | kg P per ha | | |
| 1 | Aged P(A) | 1.70 | 3.90 | 3.10 | 4.20 | 4.40 |
| | Recent P(R) | 1.80 | 3.30 | 3.80 | 4.20 | 4.30 |
| | Mean | 1.70 [a] | 3.60 [b] | 3.10 [b] | 4.20 [b] | 4.30 [b] |
| 2 | A | 1.50 | 3.30 | 2.90 | 3.30 | 3.50 |
| | R | 2.10 | 4.20 | 3.70 | 4.20 | 2.90 |
| | Mean | 1.80 [a] | 3.70 [b] | 3.30 [b] | 3.80 [b] | 3.20 [b] |
| 3 | A | 2.55 | 4.98 | 4.11 | 4.61 | 3.83 |
| | R | 2.22 | 4.59 | 3.57 | 3.82 | 5.34 |
| | Mean | 2.38 [a] | 4.78 [b] | 3.84 [b] | 4.22 [b] | 4.58 [b] |
| 4 | A | 1.91 | 3.98 | 3.20 | 4.81 | 4.31 |
| | R | 1.63 | 4.61 | 4.01 | 4.15 | 4.63 |
| | Mean | 1.77 [a] | 4.29 [b] | 3.61 [b] | 4.48 [b] | 4.47 [b] |
| 5 | A | 1.89 | 2.84 | 3.34 | 5.14 | 4.43 |
| | R | 2.21 | 4.54 | 5.59 | 5.47 | 7.52 |
| | Mean | 2.05 [a] | 3.69 [b] | 4.31 [bc] | 5.3 [cd] | 5.98 [c] |

*Influence of Rainfall on the Yield*

The amount of rainfall received by the grass during the period before each harvest is shown in the last column in Table 5. For harvests one to four, amounts of rainfall received were more than 250mm for the eight weeks growth period. However, the amount of rainfall received by the fifth harvest grass was 100mm only. Assuming

TABLE 5
The effect of P aging and rainfall on dry matter yield of *Setaria*

| Harvest No. | P interval | Mean DMY (ton/ha) | Difference due to aging (%) | Difference due to rain (%) | Rainfall (mm) |
|---|---|---|---|---|---|
| 1 | Aged (A) | 1.60 | 1.25 | | 350 |
| | Recent (R) | 1.58 | | | |
| | | | | 13.57 | |
| 2 | A | 1.42 | 2.82 | | 310 |
| | R | 1.38 | | | |
| | | | | 38.93 | |
| 3 | A | 1.92 | 2.60 | | 680 |
| | R | 1.97 | | | |
| | | | | 25 | |
| 4 | A | 1.55 | 1.29 | | 270 |
| | R | 1.57 | | | |
| | | | | 3.31 | |
| 5 | A | 1.42 | 11.83 | | 100 |
| | R | 1.59 | | | |

TABLE 6
P uptake by *Setaria* due to P aging and rainfall

| Harvest No. | P interval | Mean P uptake (kg/ha) | Difference due to aging (%) | Difference due to rainfall (%) |
|---|---|---|---|---|
| 1 | Aged (A) | 3.46 | 0.57 | |
| | Recent (R) | 3.48 | | |
| | | | | 9.81 |
| 2 | A | 2.90 | 15.2 | |
| | R | 3.42 | | |
| | | | | 20.4 |
| 3 | A | 4.02 | 2.81 | |
| | R | 3.91 | | |
| | | | | 6.05 |
| 4 | A | 3.64 | 4.67 | |
| | R | 3.81 | | |
| | | | | 12.65 |
| 5 | A | 3.53 | 29.54 | |
| | R | 5.01 | | |

that the influence of the other components of weather i.e. temperature and sunlight were similar during the growth period of the *Setaria* grass, it was observed that the highest amount of rainfall received by *Setaria* (harvest 3) resulted in the highest dry matter yield recorded among the five harvests. The lowest amount of rainfall recorded (fifth harvest) was sufficient to give a similar yield as those harvests receiving higher rainfall indicating that 100mm of rain per harvest period is adequate for normal growth of *Setaria*. At this low level of rainfall too, the effect of the interval in P application was clearly seen. The difference in dry matter yield due to the application interval was between 1 – 3% for the first four harvests whereas differences in the yield due to rainfall during the eight weeks growing period for the same harvests was between 13 – 40%. For the fifth harvest, difference in dry matter yield of *Setaria* due to the one year application interval was about 12% whereas the difference in yield due to the two months difference in growing period (difference in rainfall) was 3.31%.

*Influence of Rainfall on P Uptake*

The influence of rainfall on P uptake values was higher than the influence of P application interval for the first four harvests (Table 6). This trend was similar to that of the dry matter yield values. The fifth harvest showed a higher difference in P uptake value due to the interval in P application as compared to the rainfall.

## CONCLUSION

This study showed that P treatments have more influence than P aging on the dry matter yield and P uptake by *Setaria* grown on a Bungor Series soil. Forms of P used have no influence on both parameters recorded. Application of P fertilizers resulted in a significant increase in dry matter yield and P uptake by *Setaria*. Studies in the glasshouse (Zaharah, 1982) on Guinea grass showed a similar response to P fertilization. Rainfall received by crops during their growth period contributed substantially towards the variation in dry matter yield produce and P uptake by *Setaria*. Rainfall differences can account for up to 39% in dry matter yield and 20% in P uptake by *Setaria*. The influence of rainfall was found to be greater than the effect of P aging on the dry matter yield and P uptake in four of the five harvests of *Setaria*.

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