

**Nutrient Uptake (NPK) in Relation to Growth Stage for Pearl Millet,
Tropical Corn and Temperate Corn.**

J.A. Špitalniak, D.L. Wright, I.D. Teare*, and N.R. Usherwood

ABSTRACT

Physiological growth stages and NPK concentration and nutrient uptake in above-ground whole plants were traced for pearl millet (*Pennisetum glaucum* (L.) R. Br.) - hybrid HGM™100, tropical corn (*Zea mays* L.) - 'Pioneer 3072', and temperate corn - 'Jacques JX 247'. The study was carried out in 1993 on a Dothan sandy loam at the North Fla. Res. and Educ. Center, Quincy, Florida. The NPK concentration in plants was the greatest at early growth stages. N and P concentration was the highest for temperate corn, 3.48% and 0.38% respectively, when plants were 2 feet tall. K concentration was the highest for millet, 6.20%, when the crop was 2.5 feet tall. Under the drier than usual year but with irrigation and high fertilizer rates N and K were the most used nutrients for all three analyzed crops, N for temperate corn, with total uptake of 299.1 lb/A, and K for millet 444.5 lb/A. The stage of maximum for N uptake was maturity and for K uptake milk-soft dough. P was used least, with the highest uptake found for temperate corn, 41.2 lb/A, at maturity.

INTRODUCTION

Dynamics of plant development stages greatly influences nutrient uptake by plants. Traditionally pearl millet was managed with low energy input, but it responds to higher fertilizer rates application (Gascho et al., 1995). Maiti and Bidinger (1981) presented millet growth stages, grouping them into three phases: GS1 - roots, stem, and leaves vegetative growth; GS2 - panicle development phase, when stem elongates, leaves expand and tillers grow; and GS3 - grain filling phase, when dry weight increases. Pearl millet dry matter increases over time when

plants develop and more plant tissue use and accumulate nutrients. Gascho et al. (1995) have investigated above-ground millet whole plant nitrogen concentration in growth stage 4 and 7. Plants in stage 7 displayed lower N concentration than those analyzed in stage 4.

Sorghum (*Sorghum bicolor* L. Moench) which has a similar growth season (100 days) and plant development to millet, gradually increases nutrient uptake with development (Vanderlip, 1972). For phosphorus, which is needed more for grain filling than stalk growth (like potassium), the uptake is increasing later than for potassium. Nitrogen for sorghum is needed in a similar pattern to potassium rather than to phosphorus. NPK concentrations are the highest in half bloom stage. Hanway and Thompson (1971) found a similar NPK total uptake pattern for soybean [*Glycine maxima* (L.) Merr.] as for sorghum.

Corn, as a higher energy input crop, responds to fertilizer application more than millet. Corn growth stages indicate similar plant development, though in longer time, and NPK uptake pattern (Hanway, 1971). Crozier et al. (1994), who traced Nitrogen movement in corn, found higher N accumulation at maturity than at anthesis. Similarly, Sadler and Douglas (1994) have found that total N uptake gradually increased for corn to have reached maximum at maturity.

The objective of this study was to compare NPK concentrations over growth stages for pearl millet, temperate corn, and tropical corn. We also wanted to find the total numerical NPK nutrient uptake during the crops growing season, and to compare the three crops.

MATERIALS AND METHODS

Three studies with pearl millet, temperate corn, and tropical corn were conducted in 1993 on a Dothan sandy loam (fine, loamy siliceous, thermic Plinthic Kandiudult) at the North Florida Research and Education Center, Quincy, Florida. The soil had a compacted layer 8 to 14 inches below the surface.

Temperate corn (Jacques JX 247) was planted on February 22 in 30-inch rows into a conventionally prepared seed bed in accordance with the plow layer management concept described by Wright et al. (1988). The field was limed at 1 ton/A, harrowed, and bottom plowed prior to planting. Fertilizer applied preplant was 5-10-15 at 1000 lb/A. Micronutrients were band sprayed preemergence, Zn at 5 lb active ingredient per acre, Mn at 5 lb a.i./A, and B at 0.5 lb a.i./A. The crop was side dressed with 80 lb/A Ammonium nitrate 55 days after planting, and 100 lb N/A 73 days after planting. The third N dressing, 100 lb N/A, was applied with irrigation of 0.2" water /A 101 days after planting. Whole plants were taken to nutrient uptake analysis first, 83 days after planting (DAP) (2 feet tall); second, 91 DAP (4 feet tall); third, 107 DAP (50% tassel); and fourth, 143 DAP (maturity).

Tropical corn (Pioneer 3072) and pearl millet (HGMTM100) were planted in a conventionally prepared seed bed with KMC

planters with the rows 36 inches apart in accordance with the medium input management system described by Wright et al. (1991) and Wright et al. (1993), respectively. There were four planting dates: April 15, May 15, June 15, and July 15. Fertilizer applied preplant was 3-9-18 at 500 lb/A. Nitrogen side dressing at 120 lb active ingredient per acre was applied 36 days after planting for April planting date, 24 DAP for May planting date, 13 DAP for June planting date, and 13 DAP for July planting date.

Tropical corn plants were taken for nutrient uptake analysis first, from May planting date (PD), 38 DAP (2 feet tall); second, from June PD, 37 DAP (3 feet tall); third, from April PD, 68 DAP (50 % tassel); fourth, from May PD, 68 DAP (early milk); and fifth, from April PD, 98 DAP (early soft dough).

Pearl millet plants were taken for nutrient uptake analysis five times: first, from May PD, 38 DAP (2.5 feet tall); second, from June PD, 37 DAP (3 feet tall); third, from April PD, 68 DAP (50 % stigma emerged); fourth, from May PD, 68 DAP (milk-soft dough); and fifth, from April PD, 98 DAP (maturity).

RESULTS AND DISCUSSION

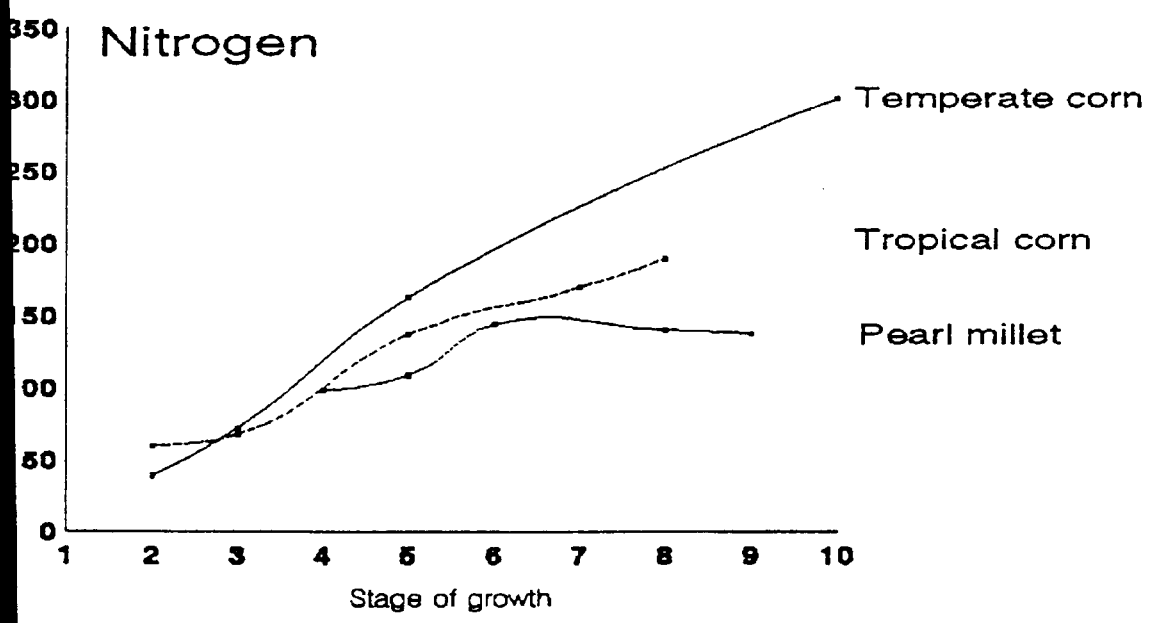
Table 1 presents growth stages, planting dates, cutting days, and NPK concentrations and total uptake for pearl millet, tropical corn and temperate corn.

Generally, nutrient concentration decreased in time and total uptake increased over plant development. Pearl millet displayed higher N and K concentration than tropical corn, and K concentration than temperate corn. Temperate corn accumulated more N and P than both tropical corn and pearl millet.

N P K uptake of pearl millet, tropical corn and temperate corn on planting date, stage of growth, days from planting to Quincy, FL 1993.

Growth stage	Description	Planting Date	Planting to Cutting (days)
4	2.5 feet tall	15 May	38
5	3.0 feet tall	15 June	37
6	50% stigma emerged	15 April	68
7.5	milk-soft dough	15 May	68
9	maturity	15 April	98
2	2 feet tall	15 May	38
3	3 feet tall	15 June	37
4.5	50% tassel	15 April	68
6.5	early milk	15 May	68
7.2	early soft dough	15 April	98
2	2 feet tall	22 Feb	83
3	4 feet tall	22 Feb	91
4.5	50% tassel	22 Feb	107
10	Maturity	22 Feb	143

K
e
A)
.
2
.6
.5
.5
.7
.
3
.0
.2
.7
.0
.
9
.6
.2
.6



erate corn
cal corn
millet
osphorus

Temperate corn, tropical corn, and pearl millet nitrogen relation to stage of growth.

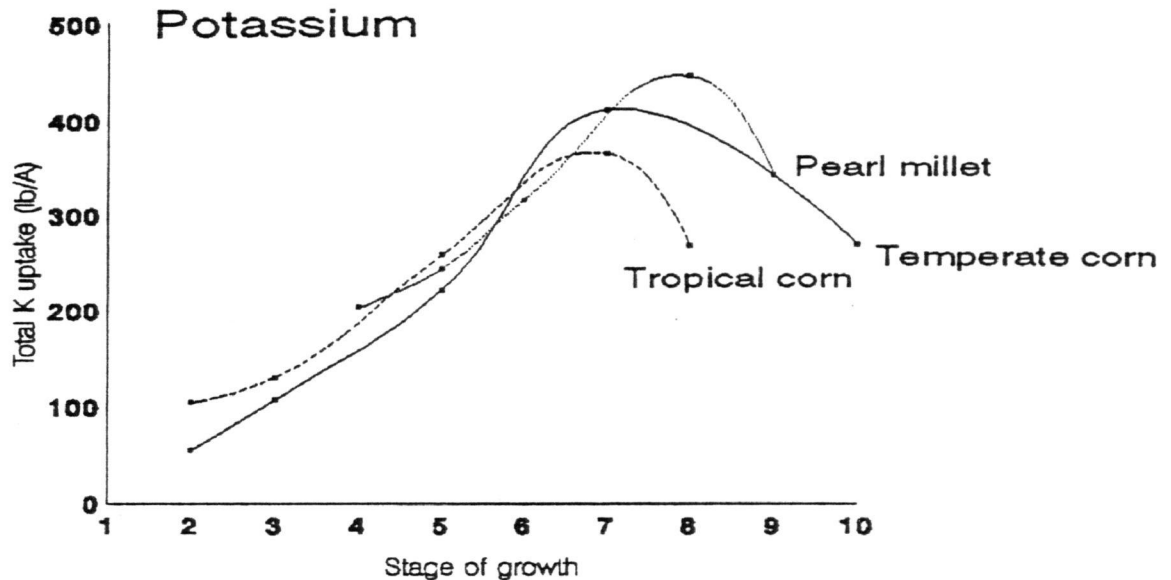


Figure 3. Temperate corn, tropical corn, and pearl millet potassium uptake in relation to stage of growth. We missed the peak with temperate corn.

Nitrogen Uptake

Pearl millet showed very high N uptake at stage 4, 98 lb/A, which did not rise significantly over time (Fig. 1) and reached its maximum, 136.7 lb/A, at maturity. Tropical and temperate corn N early uptake was similar to that of millet, 60 lb/A at stage 2 for tropical corn and 38 lb/A at the same stage for temperate corn, but was significantly higher than millet later on. The highest total N uptake was found for temperate corn at maturity, 299.1 lb/A, two times plus higher than millet. Temperate corn N uptake was also greater than millet, 188 lb/A at growth stage 7.2.

Phosphorus Uptake

Millet was found to have taken less P than both corn types, especially at late growth stages (Fig. 2). Millet maximum uptake was noted for stage 7.5, 16 lb/A, and it was much less

than maximum for tropical corn, 25.7 lb/A (stage 7.2) or temperate corn, 41.2 lb/A (stage 10). Similarly to nitrogen, phosphorus uptake was increasing during all growth season for tropical corn and temperate corn, but decreased after stage 7.5 for millet.

Potassium uptake

Millet was found to have used more potassium than both corn types (Fig. 3). From the stage 4, 203 lb/A, through the stage 9, 341 lb/A, millet displayed high P consumption, and the highest, 444.5 lb/A at milk-soft dough. The corns were similar to each other in K uptake. For the three crops K uptake decreased toward maturity, unlike N and P.

To conclude, millet displays the lowest NPK uptake potential, N and P contributes to this greatly. Temperate corn shows the highest N and P uptake.

Tropical corn uses less N and P than temperate corn but more than millet. On average, based on this study, millet uses 2-3 times more K than N and 25-40 times more K than P. Unlike millet, the corn types use slightly less N than K and 10-20 times less P than K.

Nitrogen and phosphorus uptake increase through all the growing season while Potassium uptake has its peak at about milk-soft dough stage rather than at maturity.

REFERENCES

- Crozier C.R., L.D. King, and G.D. Hoyt. 1994. Tracing nitrogen movement in corn production systems in the North Carolina Piedmont: Analysis of Nitrogen pool size. *Agron.J.* 86(4):642-649.
- Gascho G.J., R.S.C. Menezes, W.W. Hanna, R.K. Hubbard, and J.P. Wilson. 1995. Nutrient requirements of pearl millet. In: I.D. Teare (Ed.) *Proc. of First Nat. Grain Pearl Millet Symp.*
- Hanway J.J. 1971. How a corn plant develops. *Iowa State Univ. Spec. Rep. No. 48 (Rev.)*, Ames, June 1971.
- Hanway J.J., H.E. Thompson. 1971. How a soybean plant develops. *Iowa State Univ. Spec. Rep. No. 53 (Rev.)*, Ext. Svc., Ames, June 1971.
- Maiti R.K. and F.R. Bidinges. 1981. Growth and development of the pearl millet plant. *Icrisat Res. Bul. No. 6.*
- Sadler E.J. and L.K. Douglas. 1994. Higher order analysis of nutrient accumulation data. *Agron.J.* (86) 1: 26-31.
- Vanderlip R.l. 1972. How a sorghum plant develops. *The Coop. Ext. Svc. Kansas State Univ. Manhattan C-447 handbook.*
- Wright D.L., I.D. Teare, and B.T. Kidd. 1988. Ontogeny of maize in relation to sequential cropping. *Tropical Agric. (Trinidad)* 65:169-172.
- Wright D.L., I.D. Teare, and R.N. Gallaher. 1989. Corn silage production in North Florida. pp. 15-20. In I.D. Teare, E. Brown, and C.A. Trimble (Ed.) 1989 *Southern Cons. Till. Conf. Proc. SB-1. Tallahassee, Fl, July 12-13.*
- Wright D.L., I.D. Teare, F.M. Rhoads, and R.K. Sprenkel. 1993. Pearl millet as an alternate crop in a double-crop system. *Fla. Agric. Exp. Stn. Res. Rep No. NF-93-5: 1-9.*