**THE IMPACT OF LIME AND PHOSPHOROUS FERTILIZER APPLICATIONS ON THE GROWTH OF SOYABEAN (GLYCINE MAX)**

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**Abstract**

A Pot experiment was carried out in year 2004 on "Acid-Sands of Awka, Kugbo from the Derived Savanna and Akufo soil from the Southern. Guinea Savanna Agro-ecological Zones of Nigeria to evaluate the impact of lime and P fertilizer application on the growth of soybean (Glycine max). It consisted of four lime treatments (0,2,4, and 6 ton ha-1 on three soils combined with three levels (0,30, and 60kg P2 O5 ha-1 applied as SSP. The experiment was laid out in split plot design. There was significant response in the performance of soybean in the limed and P fertilized treatment compared to the unlimed and unfertilized treatments. Akufo and Kugbo soils performed significantly higher at 4 ton ha-1 of lime combined with 60kg P2 O5 ha -1 while Awka plants were best at 2 ton ha-1 in combination with 60kg P2 O5 ha -1. Generally, results reflected appreciable depression in performance when plants were treated above the optimal lime requirement. which resulted in unfavorable soil condition and reduction in plant growth

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**Keywords:** Acid sands, Amendment, fertility regeneration, fertilizer trial, Tropical soils.

**Introduction**

"Acid Sands" are acid soils that are found in parts of the tropical climate and in areas having underlying geology made up of sedimentary rocks or unconsolidated sediments (Bredenkamp, 1996). These tropical and subtropical agricultural soils formed on coastal plain sands located in the high rainfall regions are strongly acidic, low in base saturation but high in aluminum saturation (Maduakor, 1994.) The world distribution of Acid-Sands is related to climate and parent material. In Africa, the occurrence of acid-sands is prevalent in the west, south and central regions particularly Ghana and Nigeria (Plessens *et al*., 2006). In Nigeria, the occurrence covers Lagos, Ogun, Ondo, Edo, Delta, Anambra, Enugu, Oyo, Cross-River, the Federal. Capital Territory ( FAO, 2004).

Liming have been recognized as the first requirement for effective use of Acid soils in tropical areas (Lelei *et al*., 2000). The maintenance of satisfactory soil fertility levels in humid regions depends considerably on the judicious use of Lime to balance the losses of calcium and magnesium from the soil. Liming not only maintains the level of exchangeable calcium and magnesium but also provides chemical and physical environment that encourages the growth common plants (FAO, 2004). The strategy for the soil fertility management of acid soils include decreasing the detrimental effect of acidity and building the fertility status especially that of phosphorus, whereby root conditions below the plough layer will enhance absorption from the soil solution and ensure optimum utilization of an applied nutrient by plant (Bowen *et al.,* 1999) The supply and availability of phosphorus in acid soils ranges from low to medium in the plough layer of the soil, therefore, these soils will usually need P fertilizer application for optimum yield of most crops as its deficiency will prevent crops from completing their life cycle ( Buerkert *et al.,* 2001).

For successful soybean production, large quantities of lime and phosphorus (P) fertilizers may be required. (Fageria *et al*., 1994). Liming improves microbiological activities of acid soils, which in turn increase N fixation by legumes (Gllier, 2001; Bala *et al.*, 2001; Kolawole 2000) and also promotes mineralization of organic materials However, over liming may reduce crop yield by inducing p and micronutrient deficiencies ( Fageria, 1964).

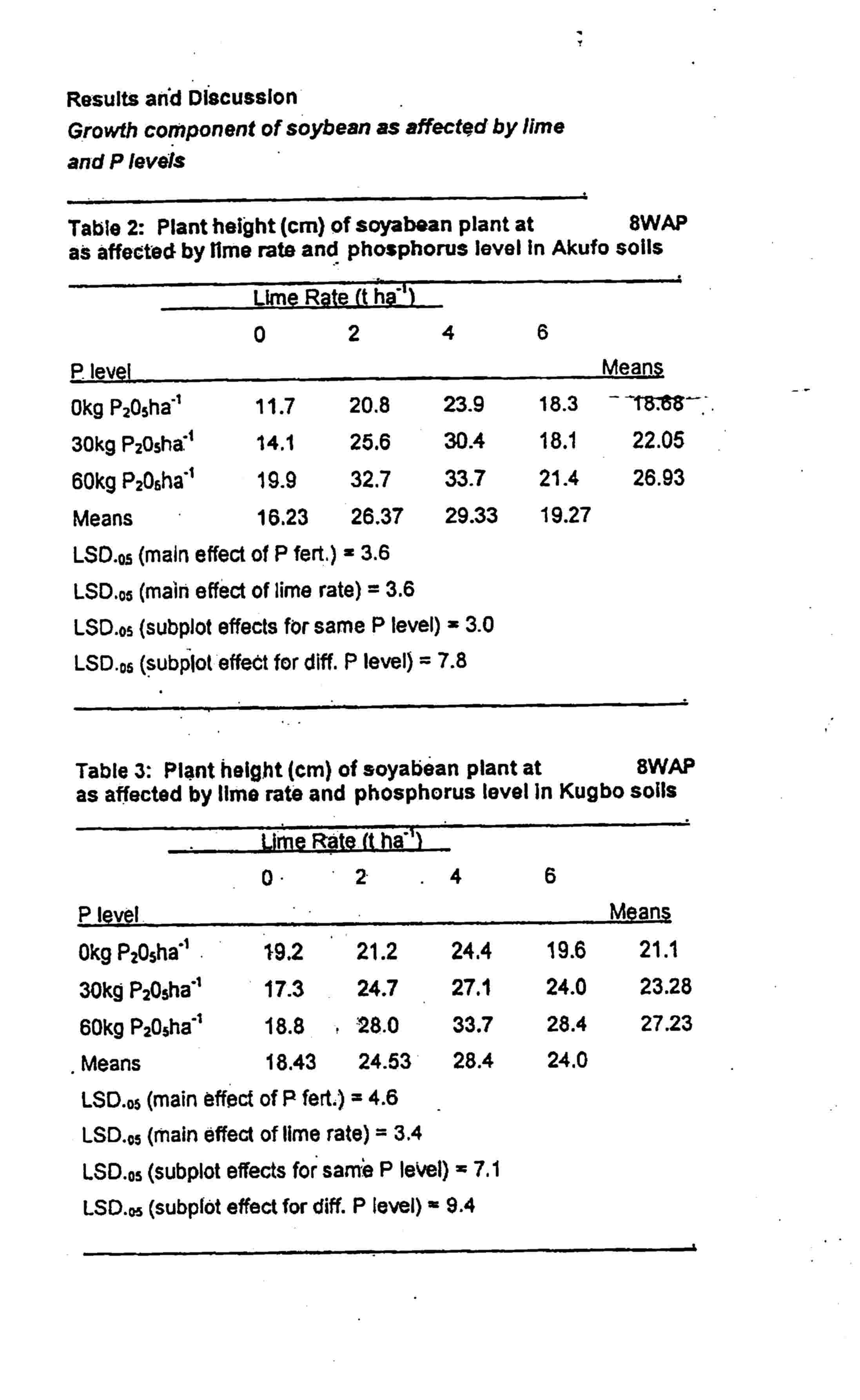
A pot experiment was therefore carried out to investigate and evaluate the impact of lime and P fertilizer application on the optimum performance of Soybean grown on acid sands from the Derived Savanna and Southern Guinea Savanna Zones of Nigeria.

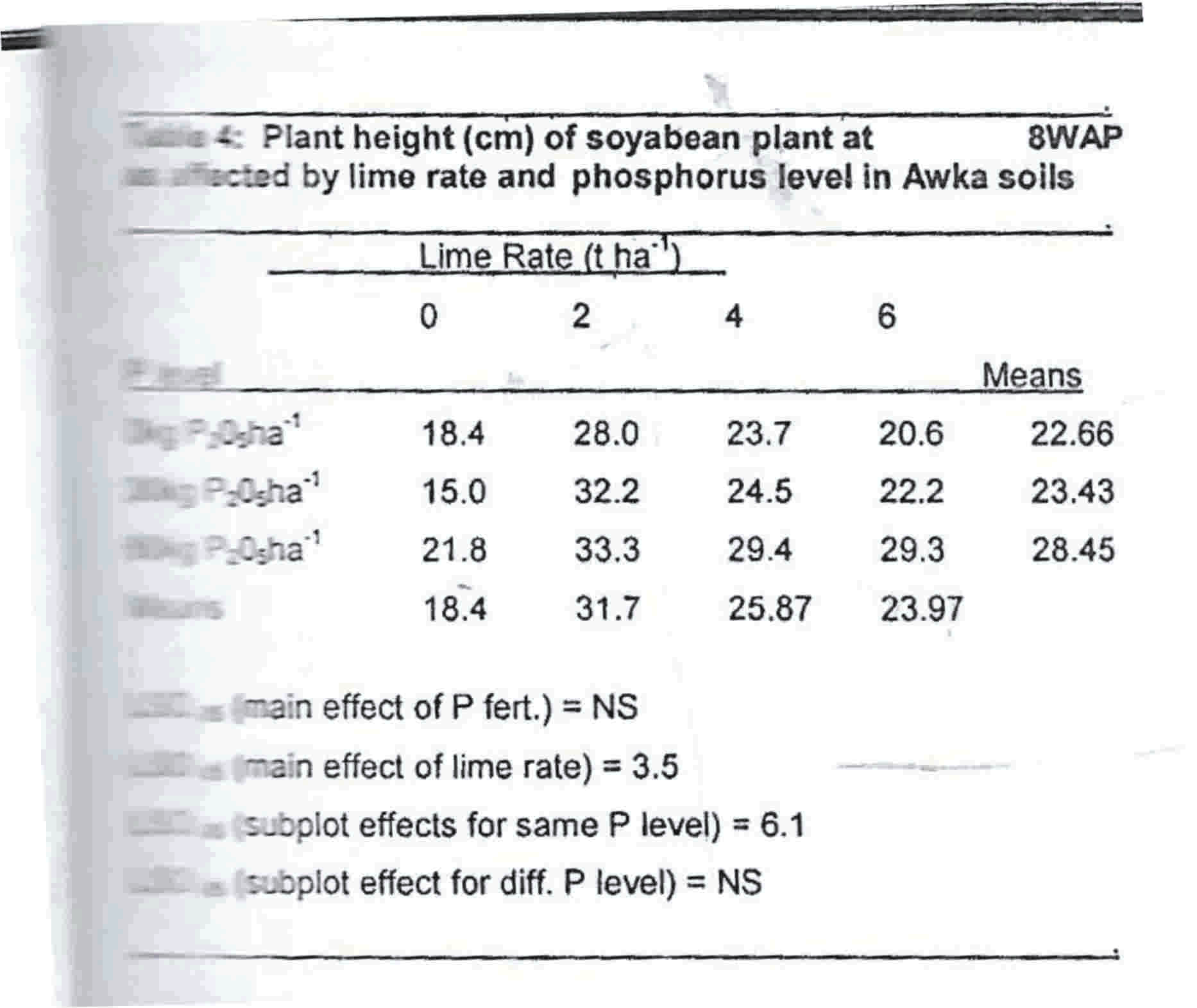
**Material and Methods**

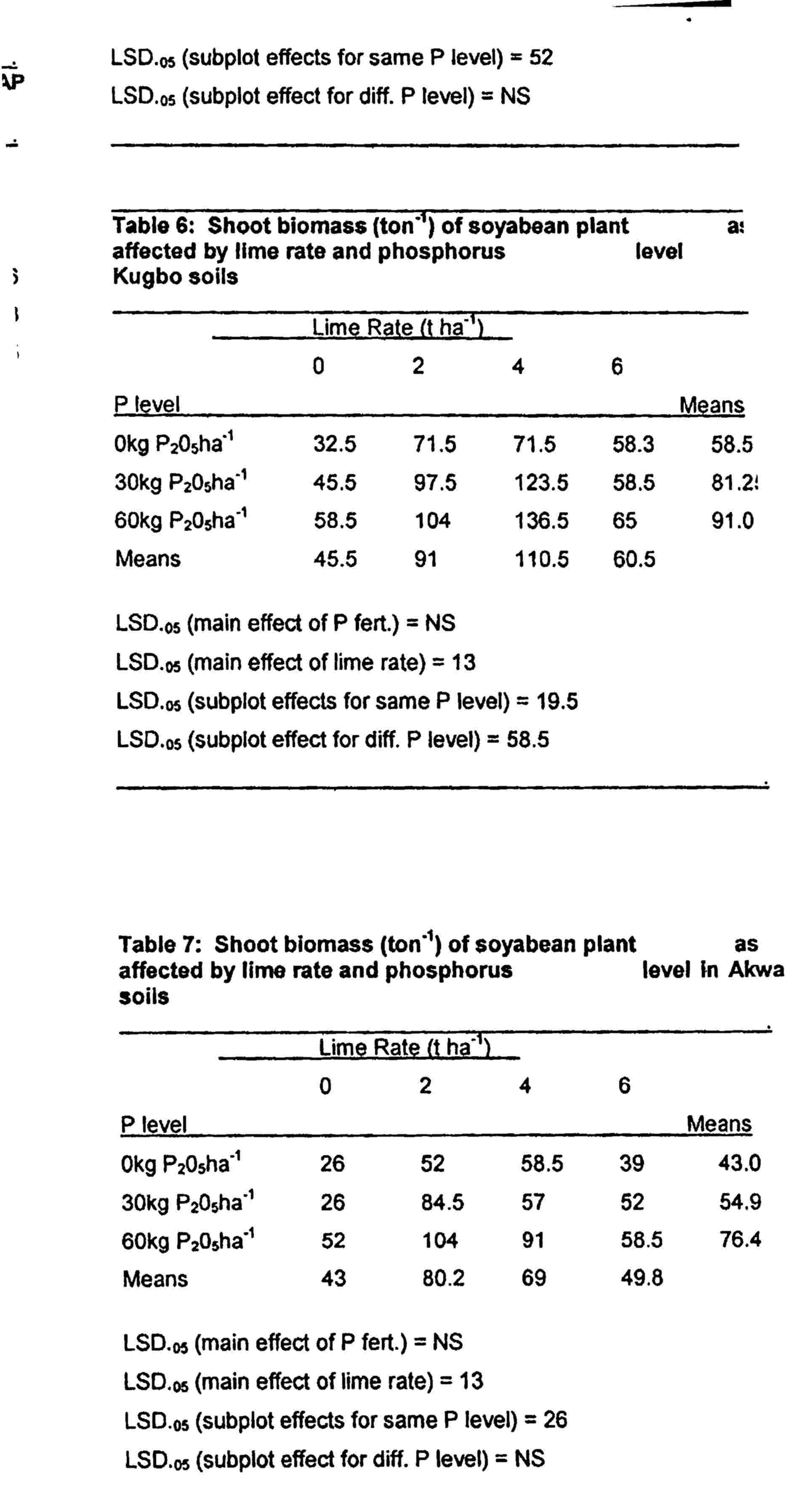
The soil samples were collected from three different locations of different pedogenic characteristics namely Akufo (Oxic or Orthic Luvisol), Awka (Typic Paleustults and Haplustults) and Kugbo (colluvium and Nupe sand stone residuum) (Ohiri *et al*., 1989; Akamigbo, 2002). The soil samples were air-dried and passed through a 2mm sieve to determine particle size by Hydrometer method, soil pH in H2,0 and 0.01 M CaCl2 by pH meter, Organic carbon by Walkley-Black method, Total N (%) by Kjeldahl method and Available P using the' Vanadomolybdate wet digestion, Exchangeable cations by Ammonium acetate (1N NH4OAC) extraction method at pH 7.0 Exchangeable Acidity and Percentage Aluminum Saturation by titration with IN HCL. Powders of Hydrated lime Ca(0H)2 and lime stone (CaC03) were obtained from Kano and Anambra States \_Agricultural Development Program, respectively, Seed of soybean (Glycine max) variety, TGX1440-1E was obtained from the Nation Cereals Research Institute (NCRI), Badeggi while the Single Supe Phosphate (SSP), 18, (% P205 ha " was obtained from the Soil Science Department Federal University of Technology, Minna. The trial involved three soils, Akufo, Awka and Kugbo, four rates of CaCO3 (0, 2, 4 and 6 ton ha-1 ) and three levels of P (0, 30 and 60 kg P205 ha-1) applied to each polythene pot containing 2.5 kg soil placed behind the soil laboratory. Five seeds of soybean (TGX 1440 -1E) were sown per pot two weeks after liming and germination test. The plants were then thinned to three plants per pot at 2WAP. The parameters measured include plant height measured at 6 weeks after planting (WAP), shoot biomass .weight and the phosphorus content of tissue after 60 days of planting. The plants were carefully uprooted and the shoots were cut at soil level while the roots were carefully washed,; rinsed and nodules collected. The shoots and the nodules were oven-dried separately and weighed for dry matter analysis while the shoots (leaves) were ground in a stainless steel grinder and sub-sample analyzed for its P content by the Vanadomolybdate yellow method following wet acid digestion. All the relevant data collected were subjected to statistical analysis using statistical analysis software (SAS. 2000). LSD was used to separate the means.

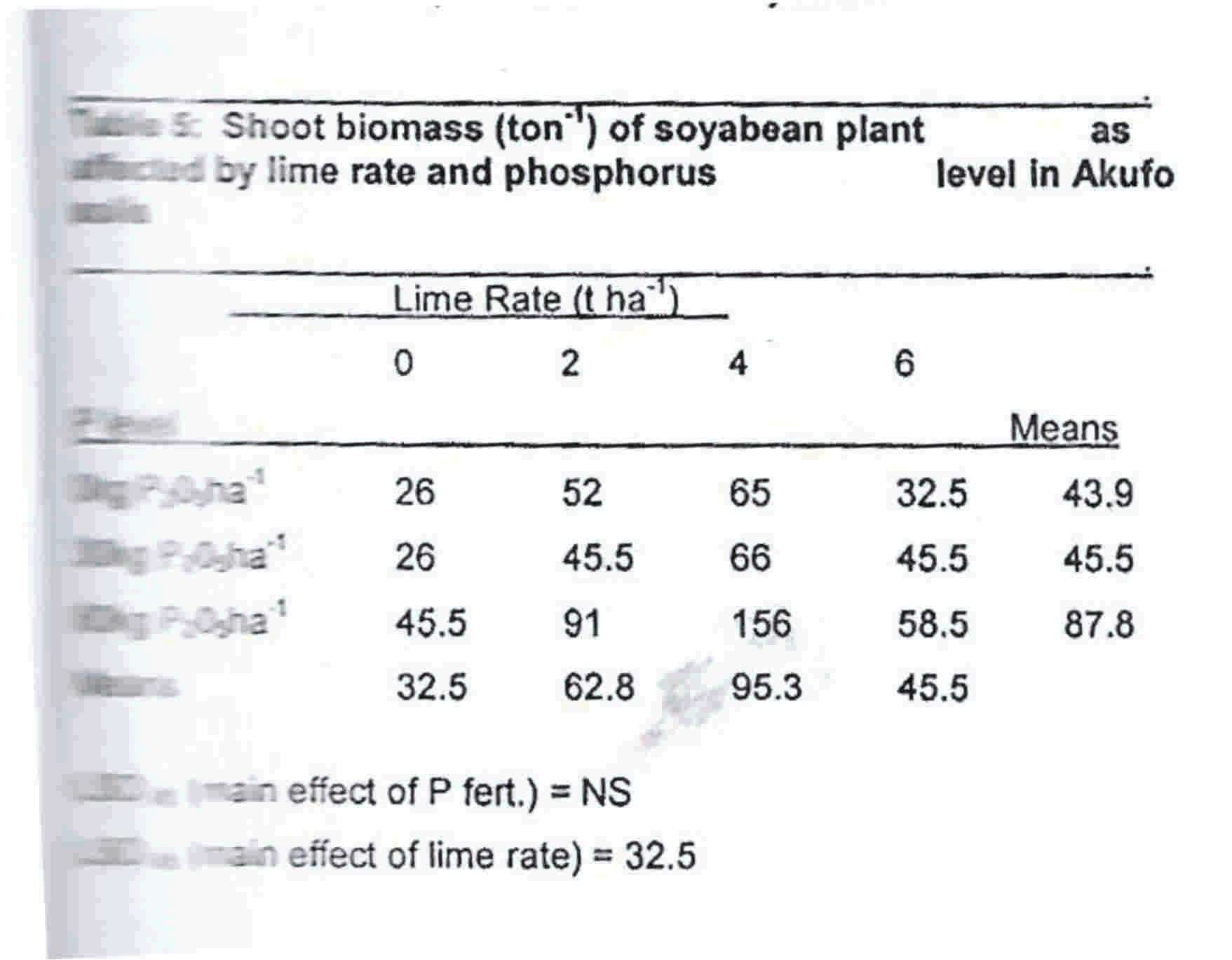
**Table 1. Selected Physicochemical Properties of Soils before liming.**





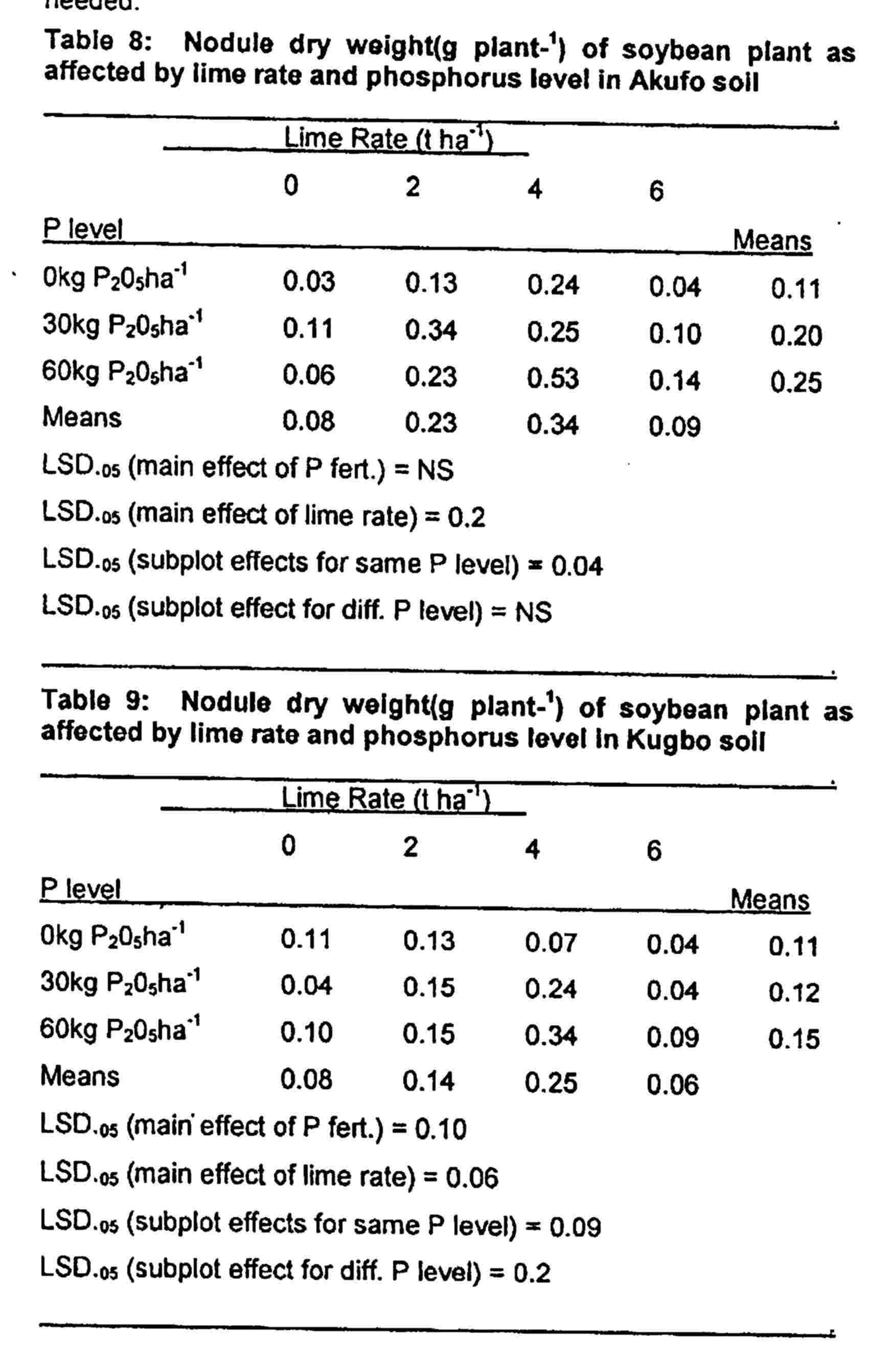
Plant height differed in response to treatments across the soils (table 2-4). The increase in height of plants when supplied with a combination of lime and phosphorus regardless of soil, may be attributed to the effect of liming on P nutrition of plants. Several workers (Johnson *et al*., 1982) have reported that liming reduced fixation of P and AL, Fe and Mn toxicity to soybean plants thereby making P available and also Ca and Mg. The amount of lime required to combine with a given. level of P in order to improve height varied with soils. Akufo and Kugbo soils gave their highest response when supplied with 4 ton ha-1 lime and 60 kg P205ha-1 while Awka plant were tallest when fertilized with 2 ton ha-1 lime and 60 kg P205ha-1 (Table 3 and 4). This is an indication that these soils averagely needed liming not more than 3 ton ha-1 when external P fertilization up to 60 kg P205 ha-1 was required. When P was not required, however, Awka soils would need liming up to 4 ton ha-1 to increase height beyond that due to 30kg P205ha-1application implying that more lime would be required to improve plant uptake of soil P better than the applied P. Mamaril *et al.* (1999) explained that lime treatments improve crop performance with time. Kamprath(1973) recorded satisfactory growth at pH 6.5 as a result of absorption of PO4 and Molybdate.





In this study, the weight of shoots varied because of treatment (Table 5-7). Liming up to 4 ton ha-1 combined with 60kg P205 ha-1 maximized weight of Akufo and Kugbo plants (Table 5 and 6) expressing improvement in growth as a result of availability of nutrients and their improved uptake. Sanginga *et al*. (2000) and Osunde *et al.* (2006) reported increased weight of cowpea tops at various rates of P applied. This response to lime of calcium source could probably be because the soil was enriched with calcium (Fageria1994). The availability of calcium to plants would however depend on uptake, of calcium which is a function of the growth of

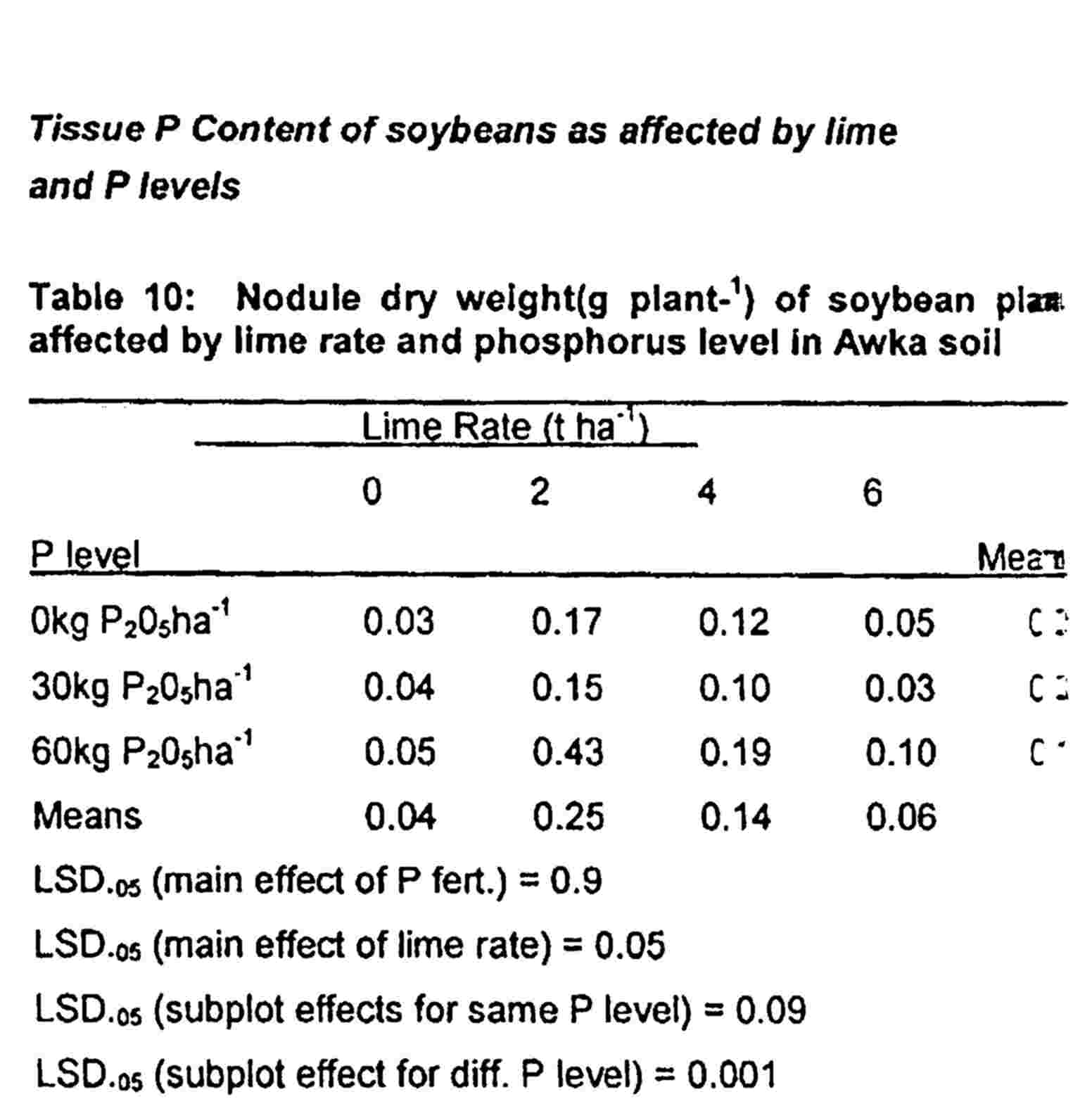
new roots (Favarreto *et al.,* 2006). More calcium in the lime was therefore taken by the new roots formed as a result of P application ( Favarreto *et al*., 2006). This probably explained why shoots were heavier when P increased at a particular lime rate. For example, shoot response at 6 tons ha-1 lime as P increased from 0 to 60kg P2O2 ha-1 regardless of soil type (Table 7). The shoot biomass of 26 ton ha-1  recorded by Awka soil at 0 ton ha-1 lime without P compared to value 0f 26 ton ha-1 when 30 kg P2O5 ha-1  was applied (Table 7) revealed that these plants were P-efficint under 0 ton ha-1 lime (Baliger *et al*., 2001). The shoot biomass of Akufo plants limed up to 0 ton ha-1 lime and 4 ton ha-1(Table 6) did not change when P was applied up to 30 kg P2O5 ha-1probably because the additional level of P was low and therefore more was needed.



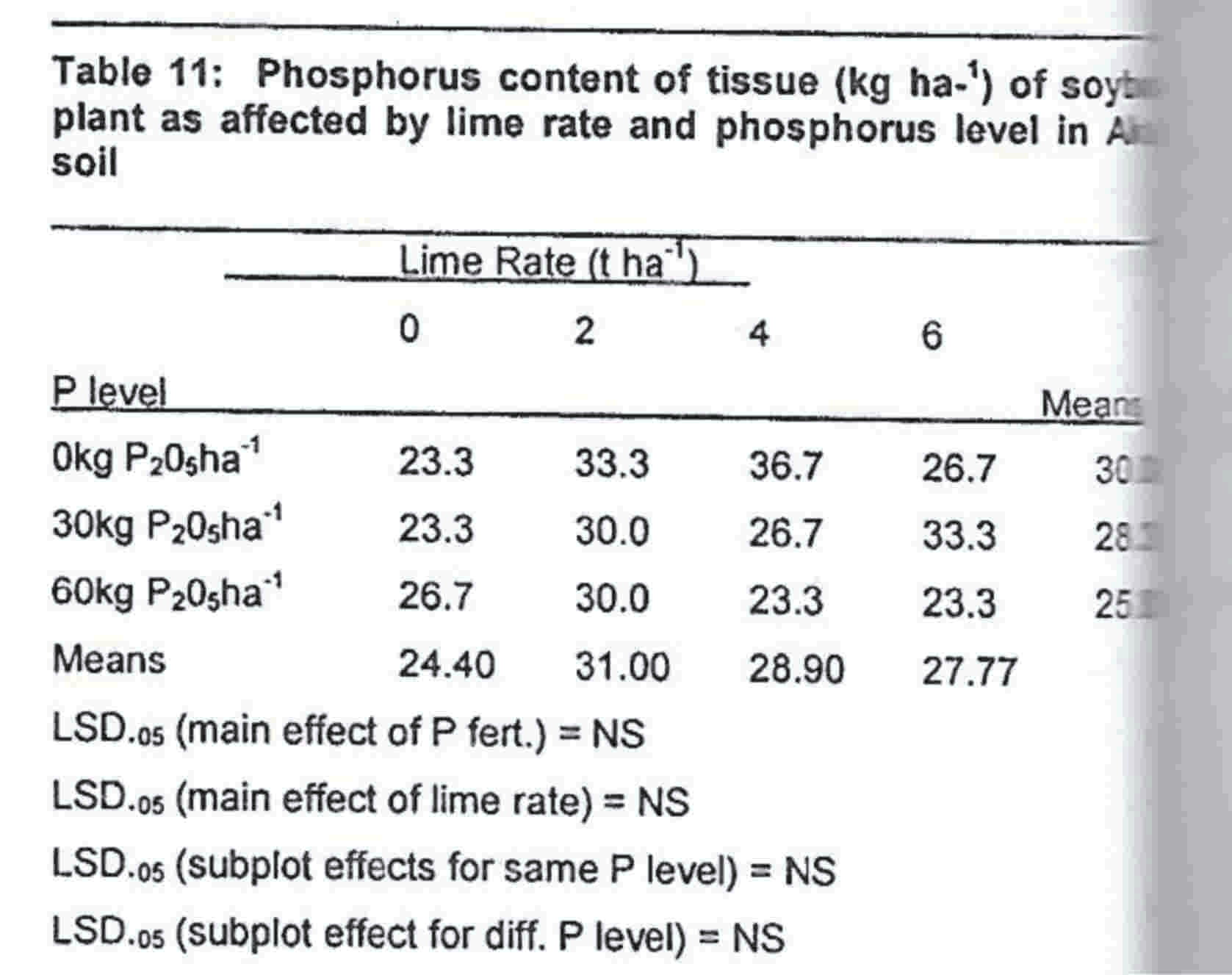
**Nodulation of soybeans as affected by lime and P levels**

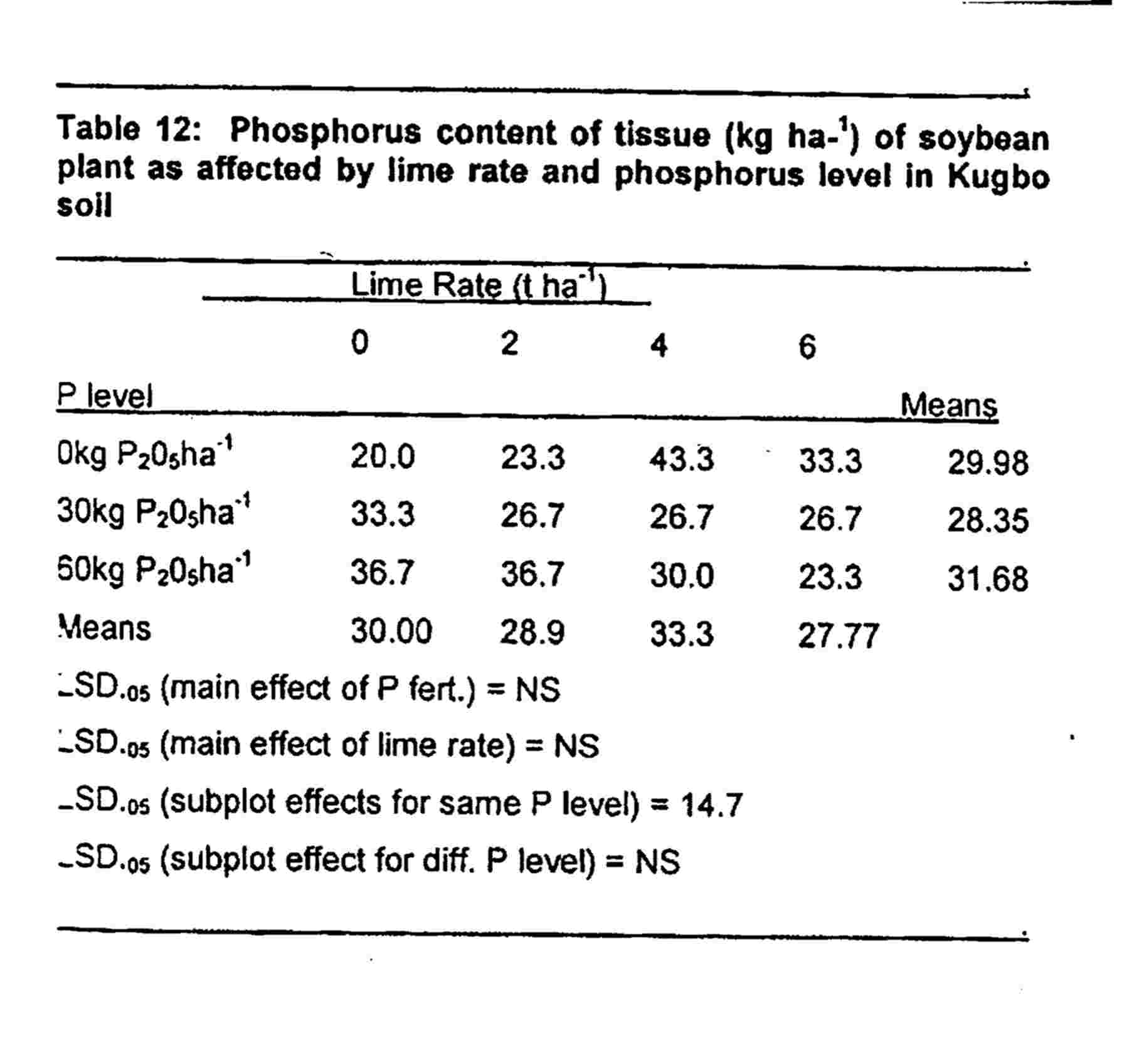
Nodulation described as nodule dry weight increased with P application. 6 ton ha-1 lime however depressed nodulation due to over liming. Fageria *et al*. (1994) reported that over liming resulted to unavailability or precipitation of P as insoluble CaPO4-. Several other workers have reported the role P plays in nodulation. According to Osunde *et al*. (2006), nodules of legumes are strong sinks for P and short supply of P was found to reduce nodulation.

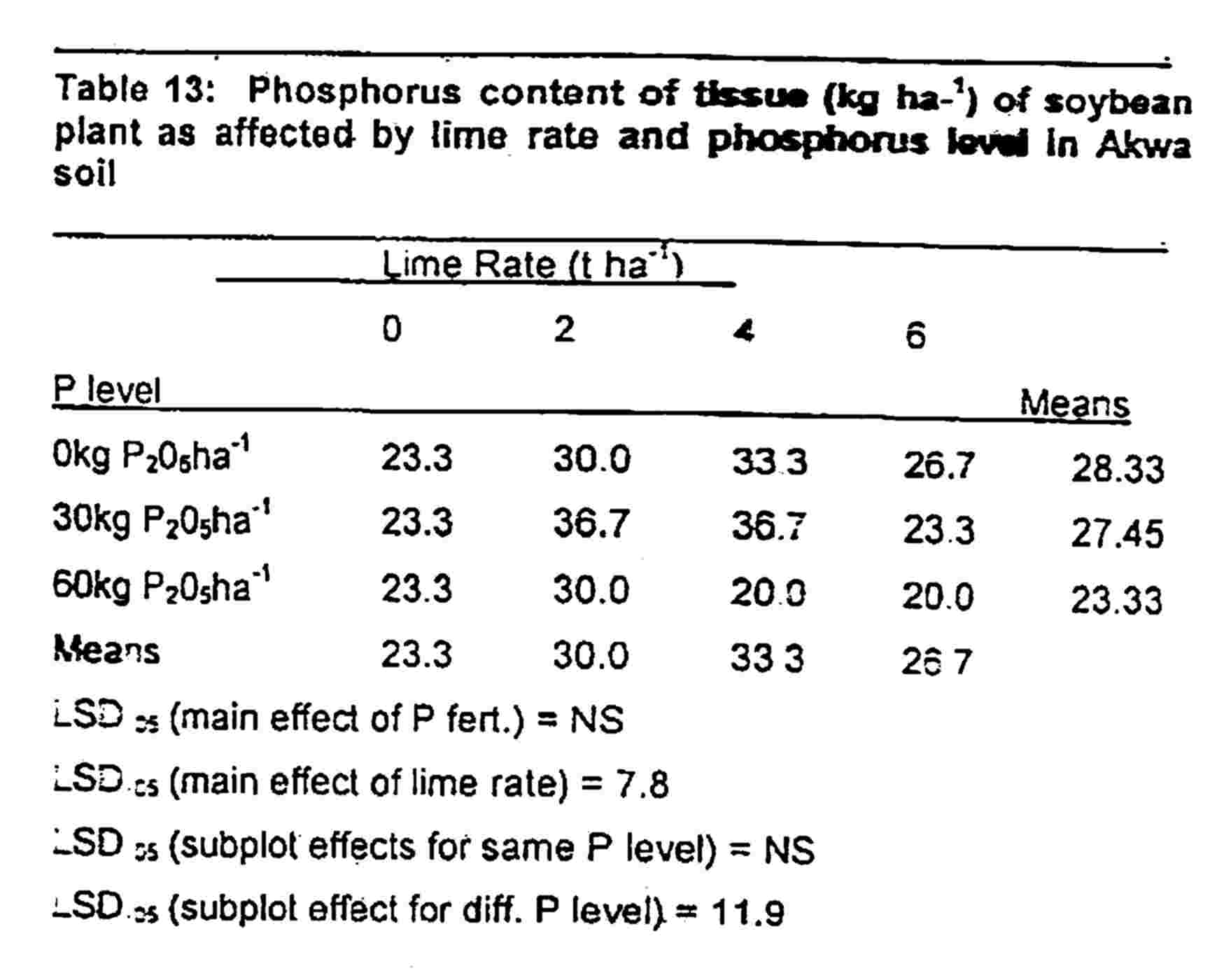
The response of soybean to P in acid soils would depend on adequate liming. Physiologically, nodule number and weight depends on the assimilate partitioning to nodules which has been reported to be a function of P and Ca availability and also the activity of microorganisms (Osunde *et al*., 2006). Growth was depressed due to a short supply of P, when lime of calcium source was inadequate.



Liming and P fertilization increased P content of tissue (Table 10 and 11 ). This may either be due to higher absorption of P by roots or due to increased root proliferation. The increase in P content of Kugbo plants with P applied under 0 ton ha-1 and 2 ton ha-1 lime respectively (Table 12) might be as a result of increased root proliferation. This Is consistent with the report of Osunde (1993), that P fertilizer increased root growth, hence reduced the need for Arbuscular Mycorrhlza Infection (AMF).

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Conclusion

Soybean plants exhibited differences in growth, tissue P concentration and nodulation across. soils. The growth and development of plants on Kugbo and Akufo soils were better averagely at any combination of P under 4 ton ha-1 lime. Similar trend was observed for Awka soils at any combination of P under 2 ton ha-1 lime. The applicatlon of 60kg P205 ha-1 however, gave the best response with little sacrifice in lime. Over liming resulted in depressions observed on growth and development. Awka soils would need liming up to 4 ton ha-1 to Increase height beyond that due to 30 kg P205 ha-1 application implying that more lime would be required to improve plant uptake of soil P better than the applied P. The tropical soil literature is full of reports citing lack of response or negative response when tropical. soils are limed. This has created the generalized idea that liming does not work in the tropics. Against this background, our reports have shown that soybeans responded to liming by improving growth and yield components. Liming should therefore be encouraged in the tropics for the cultivation of soybean on acid sands.

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