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EFFECT OF CONTINUOUS MANURING AND FERTILISATION ON MAIZE GRAIN QUALITY AND NUTRIENT SOIL ENZYME RELATIONSHIP

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ABSTRACT

An investigation to study the biochemical changes in maize under continuous application of manures and fertilisers was undertaken in Typic Ustropept soil at Tamil Nadu Agricultural University, Coimbatore. The continuous application of NPK + FYM improved the quality of maize grain by enhancing the sugar, starch and crude protein contents. The phenol content also increased. No manuring and non-inclusion of potassium and sulphur free fertiliser schedule resulted in decreased sugar, starch, crude protein and phenol contents. Appreciable variation was observed with different levels of NPK in the quality parameters of maize grain. The soil enzymes viz., amylase, catalase, cellulase, dehydrogenase, phosphatase and urease had a positive relationship with available N, P, K and organic carbon contents.

KEY WORDS: NPK + FYM, Starch, Protein, Carbohydrates, Sugars, Phenols, Soil enzymes

Recently, the grain quality assumes significance from productivity considerations. The grain quality is an integrated effect of the nutritional, physiological and biochemical factors (Srivastava and Mehrotra, 1991). As a general rule, the amount of starch/protein/carbohydrates/ sugars accumulating in the grain is a genetic parameter (Vasal *et al.*, 1980). Little information is available regarding the biochemical changes in maize due to fertilization. The knowledge on quality constitutents of maize grain as influenced by long term application of fertilizers and manures and also the relationship between available nutrients and soil enzymes gains importance. An attempt was, therefore, made to investigate the amounts of qualitative elements such as sugars, starch, crude protein and phenols that are accumulated in the grain as influenced by the differential level and sources of nutrients.

MATERIALS AND METHODS

The study was carried out in Long Term Fertilizer Experiments, which have been in progress since 1972 in Tamil Nadu Agricultural University, Coimbatore in a medium black Typic Ustropept clay loam soil during 1994. The experiment was laid out in a randomized block design comprising ten treatments replicated four times. The treatments are : (1) 50% NPK, (2) 100% NPK, (3) 150 NPK, (4) 100% NPK + Hand weeding, (5) 100% NPK + $ZnSO_4$ (25 kg ha^{-1}), (6) 100% NP, (7) 100% N, (8) 100% NPK + FYM (10 t/ha) (average composition) of FYM is as follows : N, P_2O_5 and K_2O : 0.45, 0.22, 0.55 per cent respectively) (9) 100% NPK (S free) and (10) Control. The recommended doses of N, P_2O_5 and K_2O for maize grown during 1994 as 55th crop in the sequence were 135, 67.6 and 33 kg ha^{-1}. Maize grain samples were collected from each of the treatments and analysed for quality parameters. Total sugars, carbohydrates and starch were determined as per Hedge and Hofreiter (1962). Reducing sugars were determined by Nelson-Somogyi's method given by Nelson (1944). Phenols were estimated as per the procedure outlined by Malick and Singh (1980). The total N content was determined by Micro-Kjeldahl method (Humphries, 1956) and multiplied with the factor 6.25 to arrive the crude protein. For the estimation of available N, available P, available K, and organic carbon standard procedures were followed. The grain and straw yields were recorded and the data were statistically analysed for the computation of simple correlation (Panse and Sukatme, 1967).

RESULTS AND DISCUSSION

Sugars

Significant differences was observed among the treatments for reducing and non-reducing sugars in maize grain. The FYM treatment resulted in high content of reducing sugars (1.08%) in the grains (Table 1). Increased rates of NPK promoted

Table 1. Influence of treatments on biochemical constituents (per cent) and yield (Kg ha^{-1}) of maize

S.No.	Treatment	Grain yield Kg ha^{-1}	Straw yield Kg ha^{-1}	Reducing sugars %	Non-reducing sugars %	Total sugars %	Crude protein %	Starch %	Total carbo-hydrates %	Phenol %
1.	50% NPK	2563	4343	0.66	0.55	1.21	10.33	56.50	61.00	0.13
2.	100% NPK	2913	5426	0.73	0.50	1.23	11.25	54.50	58.50	0.14
3.	150% NPK	3488	6513	0.85	0.43	1.27	11.71	52.00	57.00	0.15
4.	100% NPK + Hand weeding	3250	5849	0.92	0.27	1.18	11.35	55.40	60.50	0.14
5.	100% NPK + $ZnSO_4$ (25 Kg ha^{-1})	3506	6598	0.79	0.43	1.22	11.25	56.40	61.00	0.12
6.	100% NP	3231	5979	0.87	0.29	1.16	11.63	52.75	57.50	0.10
7.	100% N alone	1563	2851	0.87	0.36	1.22	11.94	54.93	59.00	0.12
8.	100% NPK + FYM (10 t/ha)	4775	8856	1.08	0.23	1.31	12.19	60.20	65.00	0.18
9.	100% NPK (S free)	3600	6670	0.70	0.59	1.29	10.94	54.00	59.50	0.15
10.	Control	1263	2335	0.65	0.49	1.13	10.22	51.00	56.00	0.07
	CD (P=0.05)	1162	2579	0.06	0.11	0.09	0.98	3.63	4.20	0.02

the per cent of reducing sugars from 0.65 to 0.92 which in turn was reflected on the better grain quality, while the unmanured treatment recorded lower values of reducing sugars and higher amount of non-reducing sugars which results in low quality (Pal *et al.*, 1983).

Crude protein

The crude protein content varied marginally from 10.22 to 12.19 per cent, yet these minor differences proved statistically significant implying the influence of treatment differences on this quality parameter (Table 1). The absence of either FYM or inorganic fertiliser was found to be reflected in lower protein value of the maize grain (Reddy *et al.*, 1990) and the continuous organic farming was of considerable value in increasing the protein content (Addy *et al.*, 1987 and Sarkar *et al.*, 1991). This could be attributed to the poor nutrition with concomittant effects on physiological / biochemical relations in the absence of organics and upgraded fertility environment with extended benefit of more congenial biochemical relations in plants with its addition.

Starch

From Table 1, it is seen that the content of starch had a tendency to decrease at high NPK levels. Among the treatments, combination of FYM with NPK showed the highest per cent of starch and the least content of starch was exhibited in control. The rest of the treatments had a similar influence on starch per cent. Reduced corn starch due to N manuring, as noticed here, was also reported by Baumeister (1939).

Total Carbohydrates

Considering the total carbohydrate (Table 1), it was the FYM treated plot that tended to favour higher accumulation of total carbohydrates. All the other treatments remained at par with marginal differences.

Phenols

From the biochemical activities, the phenol production (Table 1) is a specific attribute closely linked to disease resistance. It is interesting to note that FYM treatment could ensure a higher accumulation of this in the grain in tune with what was observed for protein, starch, etc. The control and K elimination accounted for a significant

Table 2. Correlation matrix between soil chemical, biochemical properties and enzyme activities (n=120)

Property	Amylase	Catalase	Cellulase	Dehydrogenase	Phosphatase	Urease
Available N	0.87**	0.88**	0.92**	0.94**	0.78**	0.99**
Available P	0.81**	0.89**	0.73*	0.79**	0.69*	0.84**
Available K	0.89**	0.82**	0.83**	0.90**	0.77**	0.96**
Organic Carbon	0.70*	0.82**	0.85**	0.90**	0.66*	0.91**
Starch	0.55NS	0.52NS	0.65*	0.62*	0.88**	0.69**
Sugars	0.83**	0.52NS	0.74*	0.76**	0.69*	0.77**
Protein	0.39NS	0.59NS	0.87**	0.75*	0.22NS	0.65*
Biomass yield	0.94**	0.50NS	0.62*	0.66*	0.82**	0.85**

**P < 0.01 *P < 0.05 NS - Non-significant

reduction in this parameter. The other treatments remained at par. This trend of result was supported by Srivastava and Mehrotra (1991).

It has become apparent that the FYM treatment possesses an over-riding beneficial effect in producing maize grain of better quality. The absence of addition of any fertilizer, elimination of S and K tended to decrease the grain quality marginally, yet significantly.

Nutrient soil enzyme relationship

Correlation analysis (Table 2) reveated that soil enzyme activities viz., amylase, catalase, cellulase, dehydrogenase, phosphatase and urease had a positive relationship with available N, P, K and organic carbon contents. It indicated that organic matter also accounted for most of the variations in the activities of soil enzymes. This positive correlation in soil could be attributed to the mineralisation of organic form of nutrients as reported by Konovalova (1981). It is also seen that grain quality parameters such as sugars, starch and protein had significant positive correlations with cellulase, dehydragenase and urease. But the activity of soil catalase was not significantly influenced by starch, sugars and protein and the amylase was not influenced by starch and protein. The correlation studies had clearly indicated that the grain and straw yields were significantly related to the activities of all the six of the enzymes studied (Arutyunyan *et al.*, 1988). The positive correlation of enzyme activities in soil might be due to increased microbial activities and thus creating conducive environment for higher enzyme production. It is obvious that the soil enzyme dynamics and mineralisation of nutrients were interrelated which promoted the recycling of nutrients in a soil plant ecosystem.

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INTERACTION EFFECT OF *GLOMUS FASCICULATUM* AND *TRICHODERMA VIRIDE* ON THE GROWTH OF SUNFLOWER

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ABSTRACT

Combined inoculation of *Glomus fasciculatum* and *Trichoderma viride* showed a positive influence on the growth, per cent root colonization by *Glomus fasciculatum* and uptake of phosphorus by sunflower when compared to individual inoculation or uninoculated control at different stages of sampling. The results show a synergistic effect of *Glomus fasciculatum* and *Trichoderma viride* on the growth of sunflower and indicate the potential benefits of using combined inoculations.

KEY WORDS : *Glomus fasciculatum, Trichoderma viride,* Compatability

VAM fungi can improve plant growth through increased uptake of phosphorus and other nutrients. Plants infected with mycorrhizal fungi show significant increase in yield as compared with non-mycorrhizal plants. Some specific interactions have been reported between VAM fungi and other microbial groups commonly present in the plant rhizosphere. Chandrasekara *et al.* (1995) reported that at flowering and maturity stages of sunflower, root colonization, spore count, total dry biomass and total P uptake were higher in VAM inoculated plants. Sunflower plants inoculated with dual inocula of *Glomus intraradix* and *Glomus mosseae* increased the growth of plant when compared to those inoculated with single inocula of VAM fungi (Mehrotra *et al.*, 1995). Windham *et al.* (1986) reported that *Trichoderma* spp. produced a growth regulation factor that increased the rate of seed germination and dry weight of shoots and reduced the root rot incidence (Ramakrishnan *et al.*, 1994). Calvet *et al.* (1992) reported that four different strains of *Trichoderma* spp. stimulated spore germination and mycelial growth of *Glomus mosseae* in monoxenic culture on water agar and one of them exerted a growth stimulation effect on marigold plants (*Tagetes erecta* L.) inoculated with *Glomus mosseae* (Calvet *et al.*, 1993). *Trichoderma aureoviride* and *Glomus* spp. when applied in combination to citrus increased mycorrhizal root colonization and plant growth (Camprubi *et al.*, 1995).

MATERIALS AND METHODS

Trichoderma viride was multiplied on molasses yeast medium (Papavizas *et al.*, 1984). Formulation of *Trichoderma* was prepared by mixing with talk powder at 1:2 (v/w) and dried in shade. About 10 gram of VA-mycorrhizal bulk inoculum consisting of soil with spores and vegetative mycelium was mixed with 5 kg soil