International Journal of Forestry and Crop Improvement
Volume 7 | Issue 1 | June, 2016 | 67-71 | ■Visit us : www.researchjournal.co.in
e ISSN-2230-9411

RESEARCH ARTICLE

DOI: 10.15740/HAS/IJFCI/7.1/67-71

Influence of organic manures, micronutrients and arbuscular mycoriza on quality parameters of (maize and sunflower) under residual effect of maize- sunflower cropping system

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ABSTRACT : Field experiments were conducted to study the influence of organic manures, micronutrients and arbuscular mycorrhiza (AM) on the productivity of maize-sunflower cropping system at Tamil Nadu Agricultural University, Coimbatore during 2011-12 and 2012-13. The experiment was laid out in Split Plot Design and replicated thrice for maize during winter 2011-12 and 2012-13 and the same experiment after dividing each plot into two was laid out in Split-split Plot Design with three replications for sunflower during summer 2012 and 2013 to estimate the residual effects of organic manures in maize, the results revealed that among the organic manures, poultry manure @ 5 t ha^{-1} with RDF recorded significantly enhanced quality parameter like crude protein and starch content in maize followed by application of sericulture waste @ 5 t ha^{-1} with RDF. Among the micronutrients and AM, $ZnSO_4$ @ 37.5 kg ha^{-1} recorded significantly crude protein and starch content followed by application of followed by TNAU MN mixture. In sunflower, better oil yield and oil quality were recorded with application poultry manure @ 5 t ha^{-1} with RDF to preceding maize followed by sericulture waste @ 5 t ha^{-1} with RDF to preceding maize. The same trend was also noticed in the second year crop.

KEY WORDS : Organic manures, Micronutrients, AM, Maize, Sunflower, Crude protein, Starch, Oil quality

HOW TO CITE THIS ARTICLE : Mariappan, G., Amanullah, M. Mohamed, Ananthi, T. and Dhananivetha, M. (2016). Influence of organic manures, micronutrients and arbuscular mycoriza on quality parameters of (maize and sunflower) under residual effect of maize- sunflower cropping system. *Internat. J. Forestry & Crop Improv.,* **7** (1) : 67-71, **DOI: 10.15740/HAS/IJFCI/7.1/67-71.**

ARTICLE CHRONICAL : Received : *02.02.2016;* Revised : *17.04.2016;* Accepted : *19.05.2016*

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INTRODUCTION

Maize (*Zea mays* L.) is the third most important cereal next to rice and wheat, at global level as well in India. It is a versatile crop and can be grown under diverse environmental conditions and has multidimensional uses in manufacturing of wide array of products such as starch, plastic, rayon, textile, adhesive,

dyes, resins, polish, syrups, ethanol, etc. It has got immense potential and is therefore referred to as "miracle crop" and also "queen of cereals". Maize, being a C_4 plant is an efficient converter of carbon and absorbed nutrients into food. Apart from the yield, the grain quality assumes significance from productivity considerations. The grain quality is an integrated effect of the nutritional, physiological and biochemical factors. The amount of starch/ protein accumulating in the grain is a genetic parameter. However, marginal changes in the quality do occur due to environmental changes. The effect of this differential treatment on the grain quality is, therefore, of particular interest and hence, investigations on the amount of protein and starch accumulating under each of the treatmental conditions were taken up.

Protein is the major nutritive constituent of grain, which determines the ultimate quality of grain. Among the organic manures, poultry manure recorded higher crude protein and starch content followed by sericulture waste and both were comparable with each other. This might be due better uptake and utilization of available nitrogen in supplied by poultry manure and sericulture waste. The increased crude protein content recorded under application of poultry manure could be ascribed to the fact that the protein content had a higher degree of positive relationship with the rate of photosynthesis which might have favourably increased by micro and macronutrients supplied by poultry manure. Similar result of increase in crude protein content due to poultry manure application was also reported by Vadivel (2003). Zinc is vital for protein and amino acid synthesis as reported by Logeragan *et al.* (1982); Mukhtar *et al.* (2011) and Rafiq *et al.* (2010). Higher protein content with application of zinc sulphate (27 kg/ha) as reported by Asif *et al.* (2013) lend support to the present finding. Higher nutrient availability to plants at critical growth stages due to appropriate combination of organic and inorganic sources of nutrients could have caused an increase in protein content in seed as reported by Khatik and Dikshit (2001). Grinev (1976) also reported higher seed and oil yields with organic manure application.

EXPERIMENTAL METHODS

Protein content :

The total N content of grain sample was estimated by micro-kjeldahl method as per the procedure given by Humphries (1956) and the content of N was multiplied by a factor 6.25 to obtain the crude protein content and expressed in per cent.

Starch content :

The starch content in the plant sample was estimated by Anthrone method as suggested by Hegde and Hofreiter (1962) and expressed in per cent.

Oil content :

Oil content of seeds was estimated by using Nuclear Magnetic Resonance (NMR) spectrometer against a standard reference sample (Granlund and Zimmerman, 1975).

EXPERIMENTAL RESULTS AND ANALYSIS

The crude protein content which is considered as an additional quality next to starch was also influenced by the organic manures, micronutrients and AM. In the first crop during 2011-12, among the organic manures, poultry manure 5 t ha^{-1} registered higher crude protein content of 11.9 per cent followed by sericulture waste compost 5 t ha^{-1} goat manure and FYM which were comparable with each other. The least crude protein content was recorded under control. However, the crude protein content recorded under control was comparable with goat manure 5 t ha^{-1} and FYM 12.5 t ha^{-1} Considering the micronutrients and AM, $ZnSO_4$ 37.5 kg ha^{-1} recorded significantly higher crude protein content (11.8%) followed by TNAU MN mixture and were comparable. The least crude protein content was recorded under control. The crude protein content recorded in the second crop also indicated similar trend as that of the previous crop with regard to organic manures, micronutrients and AM. In the second crop of 2012-13 also, poultry manure 5 t ha^{-1} recorded higher crude protein content (13.8%) followed by sericulture waste 5 t ha^{-1} and both were comparable. The least crude protein content of 10.9 per cent was recorded under control. The crude protein content recorded in the second crop also indicated similar trend as that of the previous crop with regard to micronutrients and AM. The starch content which is considered as an important quality parameter in maize was also influenced by the organic manures, micronutrients and AM. In the first crop during 2011-12, among the organic manures, poultry manure 5 t ha^{-1}

Table 1: Effect of organic manures, micronutrients and AM on crude protein and starch content (%) of maize

Treatments	Winter 2011-12		Winter 2012-13	
	Crude protein (%)	Starch content (%)	Crude protein (%)	Starch content (%)
Organic manures (M)				
M_1 - RDF+ Farmyard manure @12.5 t ha^{-1}	11.2	64.4	12.7	65.5
M_2 - RDF+ Sericulture waste @ 5 t ha^{-1}	11.3	65.7	13.3	65.6
M_3 - RDF+ Poultry manure @ 5 t ha^{-1}	11.9	68.3	13.8	68.2
M_4 - RDF+ Goat manure @ 5 t ha^{-1}	11.3	65.2	13.1	65.5
M_5 - RDF alone (Control)	10.2	62.4	10.9	62.3
S.E.±	0.6	1.1	0.6	1.12
C.D. (P=0.05)	1.5	2.5	1.5	2.60
Micronutrients and AM (S)				
S_1 - AM @ 100 kg ha^{-1}	11.2	67.6	12.7	67.9
S_2 - $ZnSO_4$ @ 37.5 kg ha^{-1}	11.8	66.1	13.1	65.9
S_3 - TNAU MN mixture @ 30 kg ha^{-1}	11.6	65.9	12.7	65.7
S_4 - Control	10.5	62.5	12.5	62.2
S.E.±	0.3	1.0	0.5	1.0
C.D. (P=0.05)	0.5	2.0	1.3	2.0

Table 2: Residual effect of organic manures, micronutrients and AM applied to preceding maize and fertilizer level to sunflower on seed yield (kg ha^{-1}), stalk yield (kg ha^{-1}), harvest index and oil content (%) of sunflower (Summer, 2012)

Treatments	Oil content (%) (2012)	Oil content (%) (2013)
Organic manures (M)		
M_1 - RDF+ Farmyard manure @12.5 t ha^{-1}	23.41	23.81
M_2 - RDF+ Sericulture waste @ 5 t ha^{-1}	27.58	29.95
M_3 - RDF+ Poultry manure @ 5 t ha^{-1}	29.29	34.60
M_4 - RDF+ Goat manure @ 5 t ha^{-1}	23.66	27.75
M_5 - RDF alone (Control)	21.13	22.30
S.E.±	1.15	1.01
C.D.(P=0.05)	2.65	2.32
Micronutrients and AM (S)		
S_1 - AM @ 100 kg ha^{-1}	24.36	25.38
S_2 - $ZnSO_4$ @ 37.5 kg ha^{-1}	28.36	32.23
S_3 - TNAU MN mixture @ 30 kg ha^{-1}	25.47	29.03
S_4 - Control	21.86	24.09
S.E.±	0.42	0.34
C.D. (P=0.05)	0.87	0.70
Fertilizer levels (F)		
F_0 - Control	23.74	26.34
F_1- 100 % RDF	25.29	29.03
S.E.±	0.15	0.09
C.D.(P=0.05)	0.31	0.18

registered higher starch content of 68.3 per cent followed by sericulture waste compost 5 t ha^{-1}, goat manure 5 t ha^{-1} and FYM 12.5 t ha^{-1}. The least starch content was recorded under control. Considering the micronutrients and AM, AM 100 kg ha^{-1} recorded significantly higher starch content (66.1%) followed by $ZnSO_4$ 37.5 kg ha^{-1} and TNAU MN mixture and were comparable among themselves. The least starch content was recorded under control. In the second crop of 2012-13, poultry manure 5 t ha^{-1} recorded higher starch content of (68.2%). Followed by sericulture waste 5 t ha^{-1}. The least starch content of 62.3 per cent was recorded under control (Table 1). The starch content recorded in the second crop also indicated as that of AM recorded higher value comparable to $ZnSO_4$ 37.5 kg ha^{-1} . In the year 2012, among the organic manures, higher oil content of sunflower (29.29 %) was recorded under poultry manure 5 t ha^{-1} to applied preceding maize followed by sericulture waste 5 t ha^{-1}. The least oil content of sunflower was recorded under control. Among the micronutrients and AM applied to preceding maize, $ZnSO_4$ 37.5 kg ha^{-1} recorded higher oil content of 28.36 per cent followed by TNAU MN mixture and AM. The least oil content was recorded under control. With regard to fertilizer levels, 100 per cent RDF to sunflower recorded higher oil content (25.29 %) (Table 2). The unfertilized control recorded the least oil content.The oil content recorded during 2013 also indicated similar trend as that of the previous year crop with respect to organic manures, mycorrhizal inoculation and fertilizer levels. Protein is the major nutritive constituent of grain, which determines the ultimate quality of grain. Among the organic manures, poultry manure recorded higher crude protein and starch content followed by sericulture waste and both were comparable with each other. This might be due better uptake and utilization of available nitrogen in supplied by poultry manure and sericulture waste.

Poultry manure with RDF recorded significantly higher crude protein content of 10.9 per cent and 11.9 per cent during 2011-12 and 2012-13, respectively. The increased crude protein content recorded under application of poultry manure could be ascribed to the fact that the protein content had a higher degree of positive relationship with the rate of photosynthesis which might have favourably increased by micro and macronutrients supplied by poultry manure. Similar result of increase in crude protein content due to poultry manure application was also reported by Vadivel (2003). Among the micronutrients and AM, $ZnSO_4$ 37.5 kg ha^{-1} recorded higher crude protein and starch content. Zinc is vital for protein and amino acid synthesis as reported by Logeragan *et al.* (1982); Mukhtar *et al.* (2011) and Rafiq *et al.* (2010). Higher protein content with application of zinc sulphate (27 kg/ha) as reported by Asif *et al.* (2013) lend support to the present finding.

Among the organic manures, higher oil content in sunflower was recorded under poultry manure with RDF applied to preceding maize. Similar findings were also reported by Taha *et al*. (2001) in sunflower. The increased oil yield was mainly due to residual effect of poultry manure due to the supply of higher amount of nutrients. Similar view was expressed by Singh and Singh (2000). This finding is concomitant with the findings of Rajshree *et al.* (2005) who reported that the application of NPK and Zn had considerable residual effect and increased the oil content of soybean. Optimum nutrient availability and higher seed filling percentage might have helped in maximizing the oil output. Similar results reported by Taha *et al.* (2001) and Ananthi (2013) lend support to the present finding.

Acknowledgement :

The author was much grateful to the UGC (Rajiv Gandhi National Fellowship) for providing the financial support to successfully carry out my Ph.D. research in Integrated Nutrient Management studies.

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