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RESPONSE OF GENETICALLY DIVERGENT PEARL MILLET [*PENNISETUM GLAUCUM* (L.) R. BR.] VARIETIES TO DIFFERENT ORGANO-MINERAL FERTILITY MANAGEMENT

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Abstract

A field experiment was conducted during 2010-11with a premier objective to evaluate different organic amendments for organo-mineral fertility for pearl millet [*Pennisetumglaucum* (L.) R. Br.]. The experiment was set in RCBD (randomized complete block design) with split plot arrangement including four replications. The main plot treatments were organic fertilizers [fresh Farm Yard Manure (FYM), composted FYM and humic acid (HA)] and a control treatment, while 3 pearl millet varieties (Madina, Hada-Al Sham and Hindi) were in the subplots. The organic amendments were done 15 days before sowing of the crop. A basal dose of N,P, and K @ 66:30:30 kg ha^{-1} from urea and NPK 15-15-15 was applied at the time of sowing.Overall, the cropshowed best performance for composted FYM based on the millet growth, yield and mineral composition. The effect ofthe other treatmentsin the experiment was in order as: humic acid >control>fresh FYM. Of all three varieties, cv. Hindi outperformed in terms of growth and yieldunder the given nutritional regimes. Cultivar Hindi was found to be more responsive to compost FYM while cv. Madinato humic acid. The results of the present experiment depictedthat application of 18 tons ha^{-1}composted farm yard manure or18 kg^{-1}humic acid can be used as an alternative source of organic amendment. Furthermore, the results of the study highly discouraged the use of fresh FYM as it caused poor crop growth and yield. However, the promising efficacy of humic acid in this study may require further investigationat molecular level and to explore its bio-availability andinteraction with hormones in the plant and micro-organism in the rhizosphere.

Introduction

Most agicultural experts believe that organic farming is the only way to increase quantity and quality of agricultural produce (Jalaluddin & Hamid, 2011). However, in contrast, other researchers, for example, Nayak *et al*., (2012), Panneerselvam *et al*., (2012), Schulz & Glaser (2012) have practically shown that organic agriculture has lower yields. To find a better option, a combination of organic and inorganic seems to be a plausible approach (Daur & Sepetoğlu, 2012).

Millet is an important crop for fodder and Silage (Khan *et al*., 2011). For this to opt the best choice of organic fertilizer, fresh FYM, composted FYM and HA were compared as organic fertilizers. FYM is one of the bulky organic fertilizers while HA isacompact source of organic fertilizer. Both have their own advantages. FYM provides an opportunity to operate in an integrated farming system by recycling of own farm resources while humic acid can be very easily shipped. Also, it is believed that 1 kg HA substitutes for 1 metric ton of manure (Humintech, 2013) but no proper research data is available on comparison of HAwithFYM especially when integrate with inorganic fertilizers. However, a few related studies conducted to this end gave an idea for the present study. Efthimiadou *et al*., (2010), Nayak *et al*., (2010) and Anuja & Jayalakshmi (2012) showed that integration of organic and inorganic fertilization improves soils and increases yield of most crops. The idea for using a combination of organic and inorganic fertilizers, has been generated from the studies of Buyukkeskin & Akinci (2011), Abbas *et al*., (2012), Alizadeh *et al*., (2012), Amoah *et al*., (2012), Liu *et al*., (2013) who have shown combinations of manures, HA, and inorganic fertilizers more effective than if used individually.

In the present study 3 types of organic fertilizers (fresh FYM, composted FYM and humic acid) were compared for their effectiveness in promoting the growth and yield of pearl millet.

Materials and Methods

A field trial was conducted during the 2010–11 growing season at the University Farm of King Abdul Aziz University located at Hada-Al Sham, 90 km in the north-east of Jeddah. The climatic conditionsat the experimental site during the entire growth season are shown in Fig. 1.

The experiment was laid out in RCBD with a split-plot planhaving four replications. The experiment consisted of three types of organic fertilizers (fresh FYM =18 tons ha^{-1}, composted FYM =18 tons ha^{-1} and Humic Acid =18 Kg ha^{-1}) in main plots while three millet varieties (Madina, Hada-Al Sham and Hindi) in sub-plots.

The organic amendments were done in the field on 15th November 2010, 15 days before sowing the crop. The crop was sown on 15th of December and harvested on 3rd of April in the year 2011.A basal dose of NPK @ 66:30:30 kg $ha^{-1}$from urea and NPK 15-15-15was applied at the time of sowing. Irrigation, weeding and other cultural practices were uniformly carried out for all treatments.

To evaluate the effect of the treatments on crop,data were recorded oncrop growth parameters and mineral composition. All data were recorded according to standard procedures as mentioned below:

Crop growth: Plant height was calculated from average of 5 plants according to Daur *et al*., (2011). Green fodder yield was determined in each sub-plot for three central rows and the values were converted to kg ha^{-1}. Dry matter yield was determined using the procedure of Daur *et al*., (2011), where 5 sampled plants in each sub-plot were dried in an oven at 70°C and the values of the sample were converted into kg ha^{-1} based on average 5 plants covered area in the experiment.

Chemical composition of the crop: The oven-dried samples were powdered for uniformity and analytical process. Nitrogen was determined by using Kjeldahl method according to Bremner (1996) and for other elements 0.5g samples were digested in 6:2 HNO_3/H_2O_2 mixture on a hot plate for 2-3 h. After digestion, P, Ca, Mg, K, Fe, Zn Cu, and Mn were determined in the sample by Varian ICP-OES (Inductively Coupled Plasma-OpticalEmission Spectroscopy), using the instrument operatingconditions according to the manufacturer's instructions (Table 1).

Statistical analysis: Data were analyzed statistically using the MSTATC software module forRCBD with split-plot arrangement, and means were compared using the least significant differences test (Russell, 1986). Microsoft Excel (Microsoft Corp., Redmond, WA, USA) was used for drawing graphs.

Results and Discussion

The results of the experiment show a significant ($p<0.05$) difference between various organic fertilizers and varieties for plant height, leaf number and forage yield (Figs. 2-4). Also, the interaction between the organic fertilizers and varieties appeared significant ($p<0.05$) for leaf number and forage yield. The composted-FYM resulted in the production of tall plants (218 cm), maximum leaf number $plant^{-1}$ (12.2) and fresh forage yield (12.5 tones ha^{-1}). Cultivar Hindi was better in composted-FYM compared with the treatments of fresh FYM and humic acid. The probable reason of superiority of composted manure over fresh manure was that more weeds were visible in fresh-FYM amended plots and the plants were pale yellow. Such findings have been earlier reported by Allemann & Young (2002). However, it has been reported by Tahir *et al*., (2011) and Turan *et al*., (2011) that soil applied humic acid increases dry mass and plant nutrient uptake. The interaction that was observed in the study was that cv. Hindi showed best performance for leaf number and fresh forage yield with composted FYM while cv. Madina showed best performance with humic acid. Treadwell *et al*., (2007) and De Stefanis *et al*., (2012) support our results for the interaction by showing interactions of different varietiesin their studies with various organic or inorganic fertilizers.

The mineral (N, P, K, Ca, Mg and Fe) contents of millet fodder varied significantly ($p<0.05$) among the organic fertilizers (Table 2). The values of minerals (N, P, K, Ca, Mg and Fe) contents of the milletcultivars showed better results for composted FYM and HAcompared with Fresh FYM, while values for Cu and Zn of millet fodder were statistically similar in all organic fertilizer treatments viz. Composted FYM, Fresh FYM and HAexcluding control treatment where the values were low. Mn was statistically non-significant ($p<0.05$) between all the organic fertilizer treatments including control. Our results are in agreement with Ahmad*et al*. (2008), Thorup-Kristensen *et al*., (2012), who have reported that proper source of organic matter helps in efficient utilization of water that ultimately improves mineral nutrition and crop yield. The promising potential of humic acid as observed in this study has also been earlier observed by Saruhan *et al*., (2011) and Jindo *et al*., (2012).These authors have reported that humic acid increased root growth and proton pump activity as a result boost yield and yield components.

Table 1. Operating conditions and detection wavelengths for ICP-OES.

Plasma gas flow	15 $Lmin^{-1}$	Detection wavelengths (λ/nm)	
Auxillary gas flow	0.2 $Lmin^{-1}$	P	214.912
Nebulizer gas flow	0.6 $Lmin^{-1}$	K	766.455
Radio frequency power	1450 W	Ca	315.880
Sample flow	1.5 mL min^{-1}	Mg	279.071
Read delay	90 sec	Fe	259.933
Read parameters (s)	2.0 min, 5.0 max	Cu	324.747
Spray chamber	Cyclonic	Zn	213.855
Replicates	3	Mn	257.604

Table 2. Mineral composition of different millet cultivars under different organo-mineral fertility managements.

Organo-mineral fertilizers	Macro-mineral (g kg^{-1} dry matter)					Micro-mineral (mg kg^{-1} dry matter)			
	N	P	K	Ca	Mg	Fe	Cu	Zn	Mn
Fresh FYM + MF*	12.2^{b}	4.8^{b}	24.4^{b}	13.6^{b}	3.1^{b}	52.5^{b}	10.0^{a}	30.1^{a}	55.2^{a}
Composted FYM + MF	19.5^{a}	6.2^{a}	30.1^{a}	18.3^{a}	3.5^{a}	74.5^{a}	10.1^{a}	40.2^{a}	70.4^{a}
Humic Acid + MF	18.4^{a}	6.1^{a}	31.4^{a}	18.2^{a}	3.5^{a}	65.0^{a}	10.3^{a}	31.2^{a}	68.2^{a}
Control + MF	13.4^{ab}	5.1^{b}	25.0^{b}	14.3^{ab}	3.3^{b}	50.6^{b}	5.1^{b}	22.4^{b}	55.0^{a}

Mean values with different superscript letters in the same column differ significantly ($p<0.05$)

*MF = Mineral fertilizer (a basal dose of NPK @ 66:30:30 kg ha^{-1} applied uniformly to all treatments

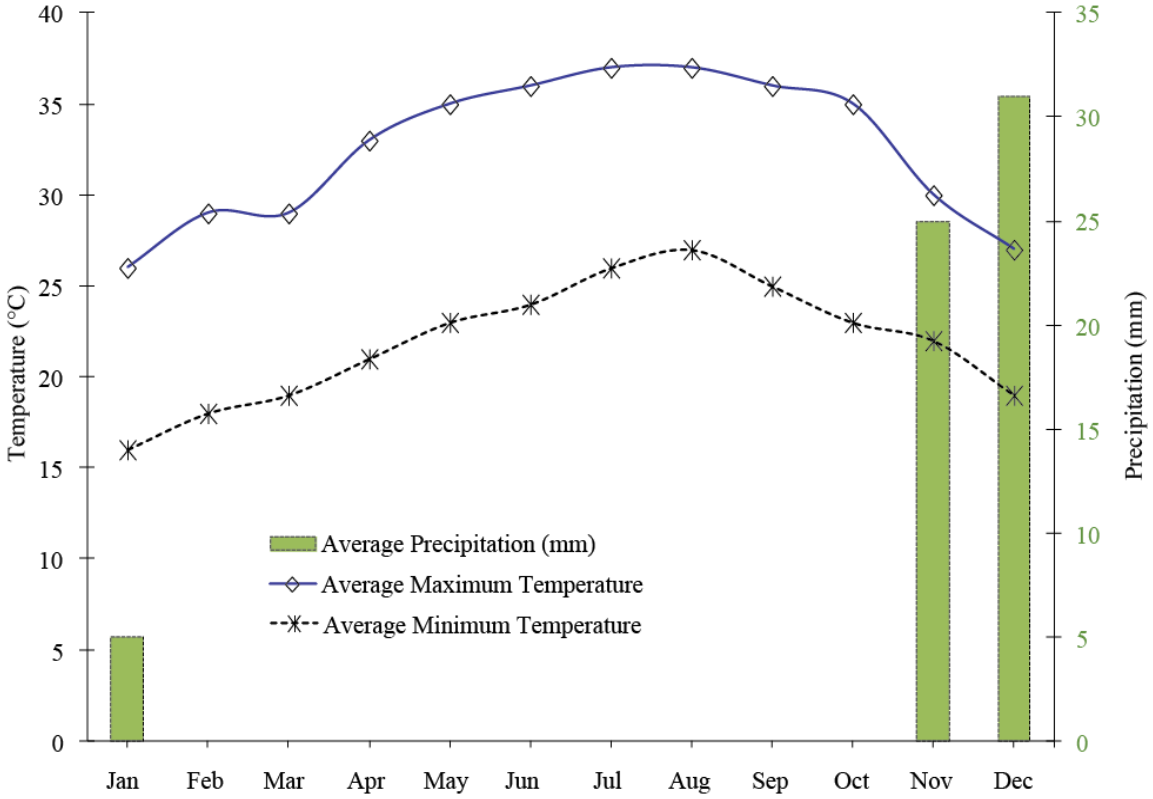

Fig. 1. Climatic conditions during the entire growth period at the experimental site (Hada-Al Sham, Jeddah-Saudi Arabia).

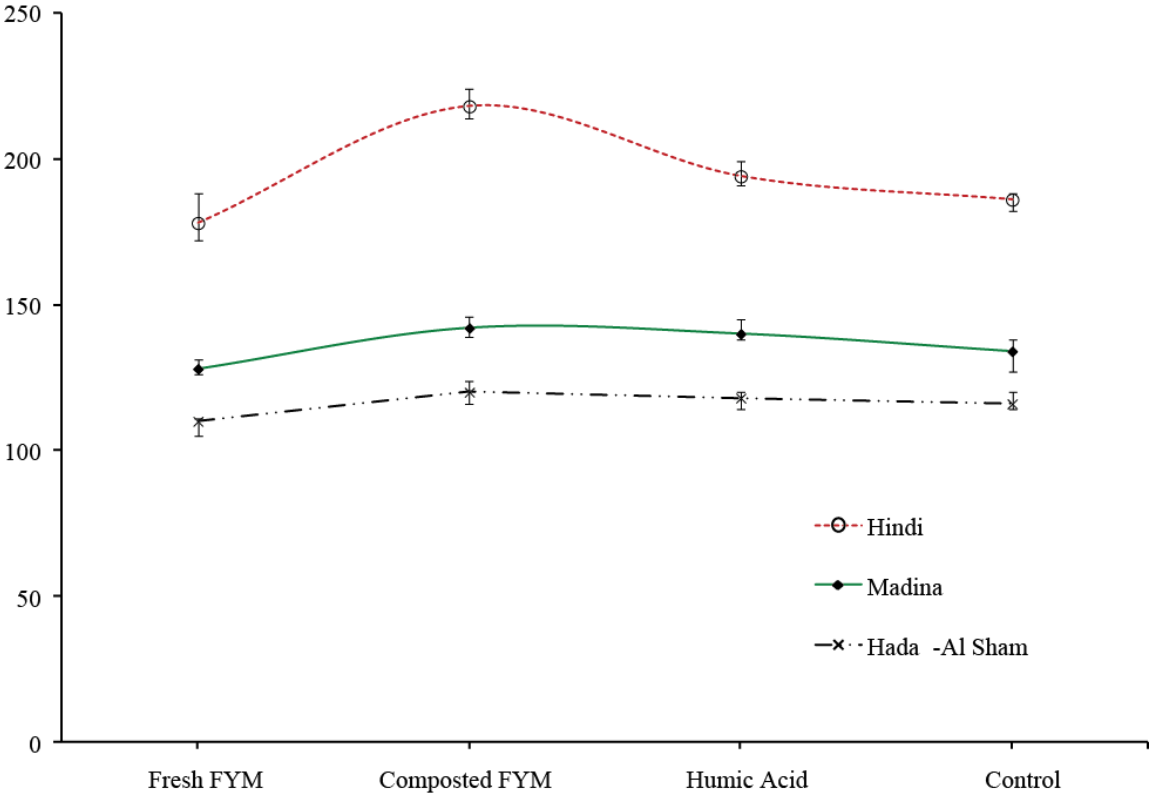

Fig. 2. Plant height (cm) of millet varieties under different organo-mineral fertility managements.

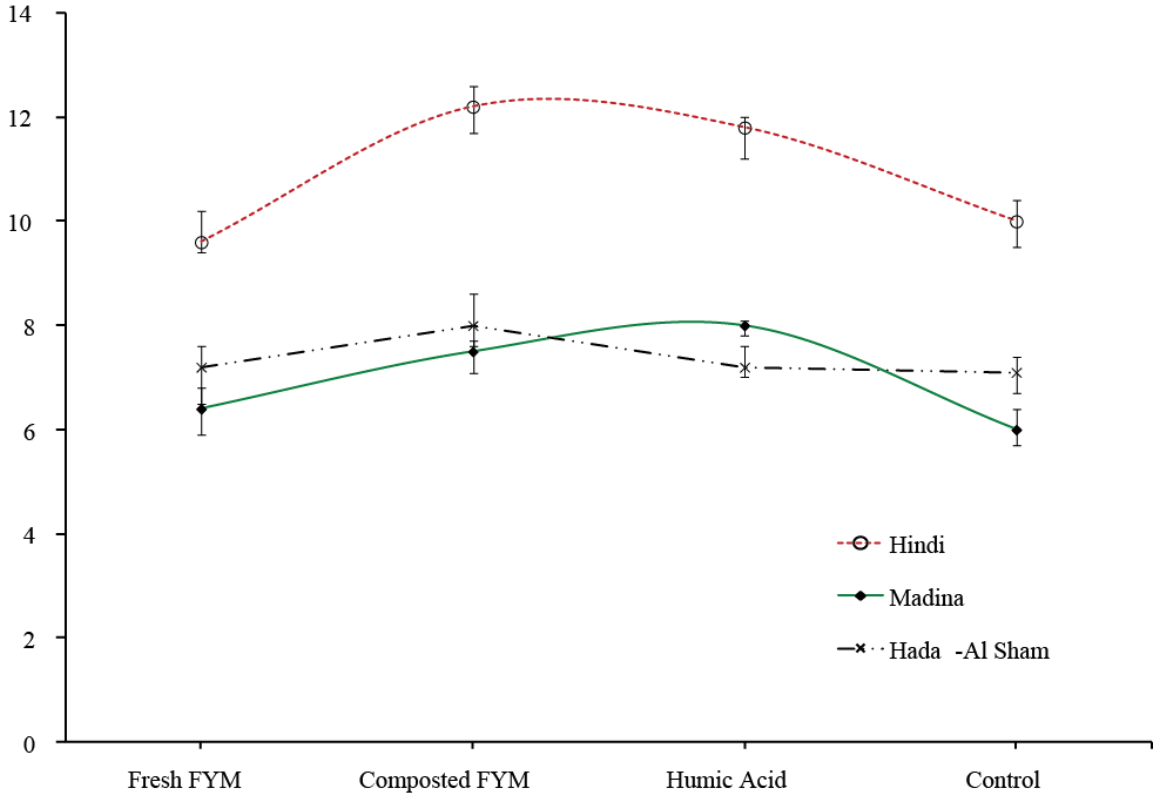

Fig. 3. Leaf number plant^{-1} of millet varieties under different organo-mineral fertility managements.

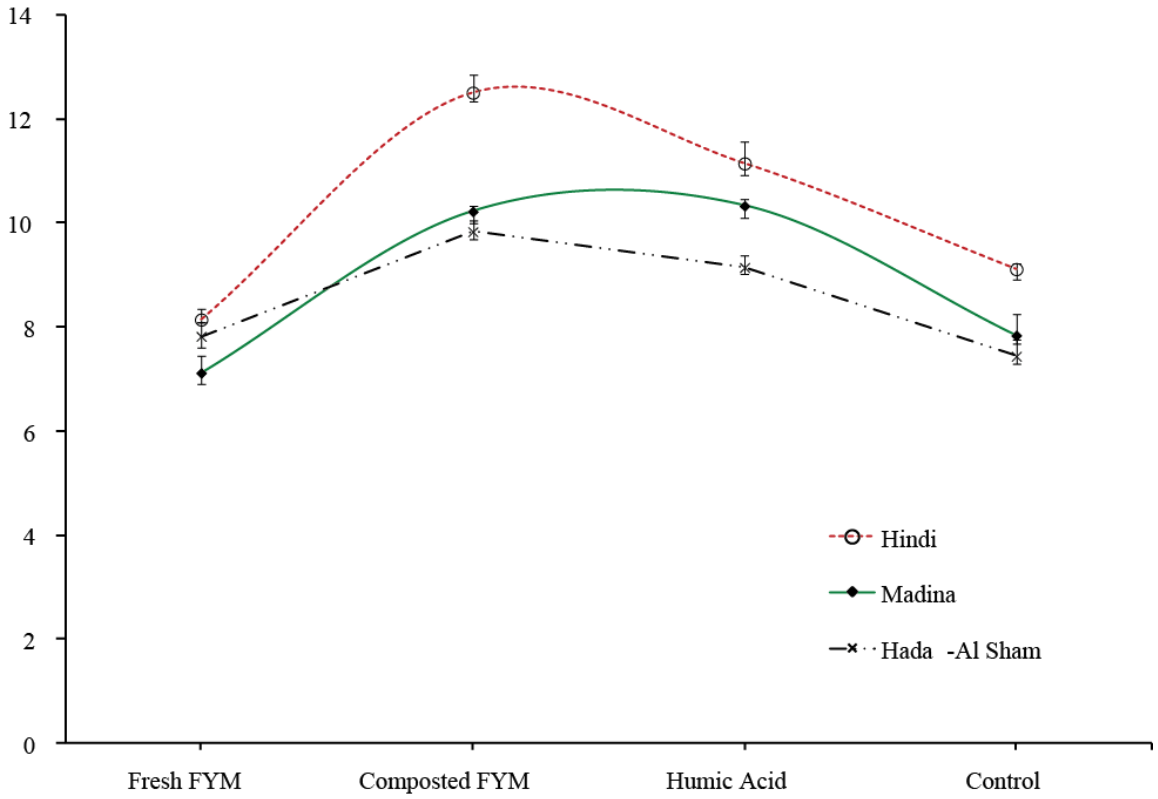

Fig. 4. Fresh forage yield (tons ha^{-1}) of millet varieties under different organo-mineral fertility managements.

Conclusions

Composted FYM integration with inorganic fertilizer increased growth and quality of millet in the present experiment. Based on the present study findings 18 tons ha^{-1} of composted FYM application to soil may be recommended. The beneficial effect of humic acid in the experiment might be due to mitigation of saline conditionsor some other biochemical reason that needs to be studied in future. Fresh FYM inhibited the millet growth.

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