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Weather, Quality Parameters and Yield of Rainfed Sunflower (*Helianthus annuus* L.) under Integrated Nutrient Management in Alfisols

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A B S T R A C T

A field experiment on rainfed sunflower was conducted during Kharif 2014 at College farm, College of Agriculture, Rajendranagar, Hyderabad to study the effect of humic acid under nutrient management practices on seed yield, oil yield, protein yield, volume weight and hull content of rainfed sunflower. The experiment was laid out in split plot design with eighteen treatments (six main and three sub treatments and replicated thrice). The six main treatments consisted of (M_1) - Absolute control, M_2 - compost @ 2.5 t ha^{-1}, M_3 - compost @ 5.0 t ha^{-1}, M_4 - RDF alone (60-60-30 kg N, P_2O_5 and K_2O) M_5 - RDF + compost @ 2.5 t ha^{-1}, and M_6 - RDF + compost @ 5.0 t ha^{-1} and the three sub plot treatments consisted of application of varying levels of humic acid granules (basal) viz., S_1 - 5.0 kg ha^{-1}, S_2 - 10.0 kg ha^{-1} and S_3 - 15.0 kg ha^{-1}. The crop was grown completely under rainfed conditions. During the crop growth period (July 9th to October 9th) a total of 329.7 mm rainfall was received in 24 rainy days and it was deficit by 57.14% over the decennial average of 519.1 mm received in 30 rainy days. A total of 11 dry spells occurred during crop growth period coinciding with the vegetative (5) and reproductive stages (6). The results revealed that among all the nutrient management practices maximum seed, oil and protein yield (1859, 741 and 224 kg ha^{-1} respectively) were recorded with the combined application of RDF (60-60-30 N, P_2O_5 and K_2O kg ha^{-1}) + compost @ 5 t ha^{-1} and the lowest oil yield, protein yield and seed yield were observed under absolute control. The effect of varying levels of humic acid and interaction effect was found to be non-significant on oil yield, protein yield and seed yield.

Keywords

Sunflower, Weather, Compost, Humic acid, Quality parameters and Yield

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Introduction

Sunflower (*Helianthus annuus* L.) occupies the fourth position among vegetable oilseeds after soybean, oil palm and canola in the world (Rodriguez *et al.,* 2002 and Ahmad *et al.,* 2011). Although sunflower is generally regarded as a temperate zone crop, it is currently cultivated on approximately 23 million hectares in 40 countries of the world, including some countries in the humid tropical Africa because it is quite rustic and can perform well under varying climatic and soil conditions (Seiler *et al.,* 2008). The major goal of growing sunflower is for its seed (achene) that contains oil (36–52%) and protein (28–32%) as reported by Rosa *et al.,* (2009). The crop has been receiving steady attention by various scientists from diverse disciplines in recent past because sunflower oil is a premium oil with light colour and is widely used in the diets of heart patients because it contains very low cholesterol and high (90%) unsaturated fatty acid concentration (Qahar *et al.*, 2010).

The importance and role of organic manures for crop production in general and under dryland agriculture in particular is well known. The normal recommendation of FYM for different crops ranges from 5 to 15 t ha^{-1}. However, due to declining cattle maintenance in farms of rainfed regions, ease and dependence on chemical fertilisers for transport and quick crop response, availability of organic manures is a serious constraint. Under this inevitable situation, the opportunity of using humic substances along with the organic manures can offset the reduced quantity of compost application.

Therefore, this study was carried out to determine the effects of weather, compost, humic acid and inorganic fertilizer application on growth, development, seed quality and yield of sunflower in dryland areas.

Materials and Methods

The present experiment on sunflower was conducted during *kharif* 2014 at College Farm, College of Agriculture, Rajendranagar, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad. The soil of the experimental site was sandy loam in texture with pH of 7.1, electrical conductivity 0.23 dSm^{-1}, low in organic carbon (0.28 %), available nitrogen (188.1 kg ha^{-1}), medium in available phosphorus (49.3 kg ha^{-1}) and high in available potassium (577.1 kg ha^{-1}). The experiment was laid out in split plot design consisting of eighteen treatments (six main and three sub treatments) and replicated thrice. There were six main treatments and the three sub-plot treatments consisted of application of varying levels of humic acid granules (Table 2). Sunflower hybrid (DRSH-1) was sown on 9th July 2014 and raised entirely under rainfed conditions. Full dose of P_2O_5 and K_2O along with half of the nitrogen in all the treatments was applied as basal. Remaining nitrogen was applied in two equal splits i.e. 1/4th at 30 DAS and 1/4th at flowering as per the treatments. Need based plant protection measures were taken. The crop was grown completely under rainfed conditions. During the crop growth period (July 9th to October 9th) a total of 329.7 mm rainfall was received in 24 rainy days and it was deficit by 57.14% over the decennial average of 519.1 mm received in 30 rainy days. A total of 11 dry spells occurred during crop growth period coinciding with the vegetative (5) and reproductive stages (6).

Oil content and oil yield (kg ha^{-1})

For oil estimation seed sample was drawn from each treatment net plot produce. The oil content of seed for each treatment was determined by using continuous type pulsed Nuclear Magnetic Resonance (NMR – oxford MQC) as suggested by Tiwari *et al.,* (1974) and thereby oil percent in the seed was recorded directly. By multiplying oil content with the seed yield ha^{-1} oil yield (kg ha^{-1}) was estimated.

$$\text{Oil yield} = \frac{\text{Seed yield x oil content (\%)}}{100} \text{ kg ha}^{-1}$$

Protein yield (kg ha^{-1})

The protein yield (kg ha^{-1}) was estimated by multiplying seed yield (kg ha^{-1}) with protein content; and the protein content (%) was estimated by multiplying the percent concentration of nitrogen in the seed with 6.25 (Walinga *et al.*, 1989).

Protein yield = seed yield x protein content

$$\text{Protein content} = \frac{\text{Seed yield x N content x 6.25 kg ha}^{-1}}{100}$$

Volume weight (g/50 ml)

For the estimation of volume weight a 50 ml empty beaker was taken and its weight was recorded. The beaker was filled upto the rim with sunflower seed as per the treatments and the weights were recorded.

The volume weight of each treatment was estimated by subtracting the beaker weight from the total weight (beaker + seed) of the respective treatments. Volume weight is expressed in grams.

Hull content (%)

For the estimation of hull content**,** 10 g of seed from each treatment was weighed followed by soaking in water for 3 hours.

The soaked seed was dehulled as per the treatments and weighed after sufficient period of shade drying. The weight of hull in each treatment was expressed as hull content in percentage.

The data was statistically analyzed duly following the analysis of variance technique for split plot design as suggested by Panse and Sukhatme (1978).

The statistical significance was tested with F test at 0.05 level of probability and where ever the F value was found significant, critical difference (CD) was worked out to test the significance.

Results and Discussion

Weather conditions during the crop growth period

An overview of the rainfall data (Table 1 and Fig. 1) indicated that a total of 329.7 mm rainfall was received during the crop growth period (9^{th} July to 9^{th} October, 2014) in 24 rainy days and it was deficit by 57.4% over the decennial average of 519.1 mm received in 30 rainy days.

Perusal of the rainfall distribution during different crop growth phases revealed that an amount of 49.8 mm was received during seedling stage (0 - 30 DAS), 40.5 mm at the vegetative stage (30-45 DAS), 160.4 mm during the reproductive stage (45 - 60 DAS) and 79.0 mm during the seed development stage (60 DAS - harvest) respectively. There was a coincidence of continuous 5 dry spells during vegetative stage and consecutive 6 dry spells during the reproductive and seed development stage as evident from the respective data (Table 1).

Further the data on the weather parameters indicated that the mean maximum temperature (30.6 ^{0}C) wind speed (13.7 km hr^{-1}) and the evaporation (3.1 mm) were relatively higher during the initial crop growth stages (0 – 30 DAS).

There was a gradual increase in these weather parameters except wind speed with the advancement of crop age (30 – 45 DAS). However at the later stages (45 – 60 DAS) on account of the higher rainfall received (160.4 mm) there was a decrease in maximum temperatures (29.2 ^{0}C), wind speed (5.5 km hr^{-1}) and evaporation (2.4 mm day^{-1}) indicating the inter relationship between these parameters, and the rainfall thus bringing a change in the micro climate and better availability of soil moisture.

Fig.1 Rainfall (mm), maximum temperature (^{0}C), evaporation (mm) and wind speed (km hr^{-1}) during different crop growth stages

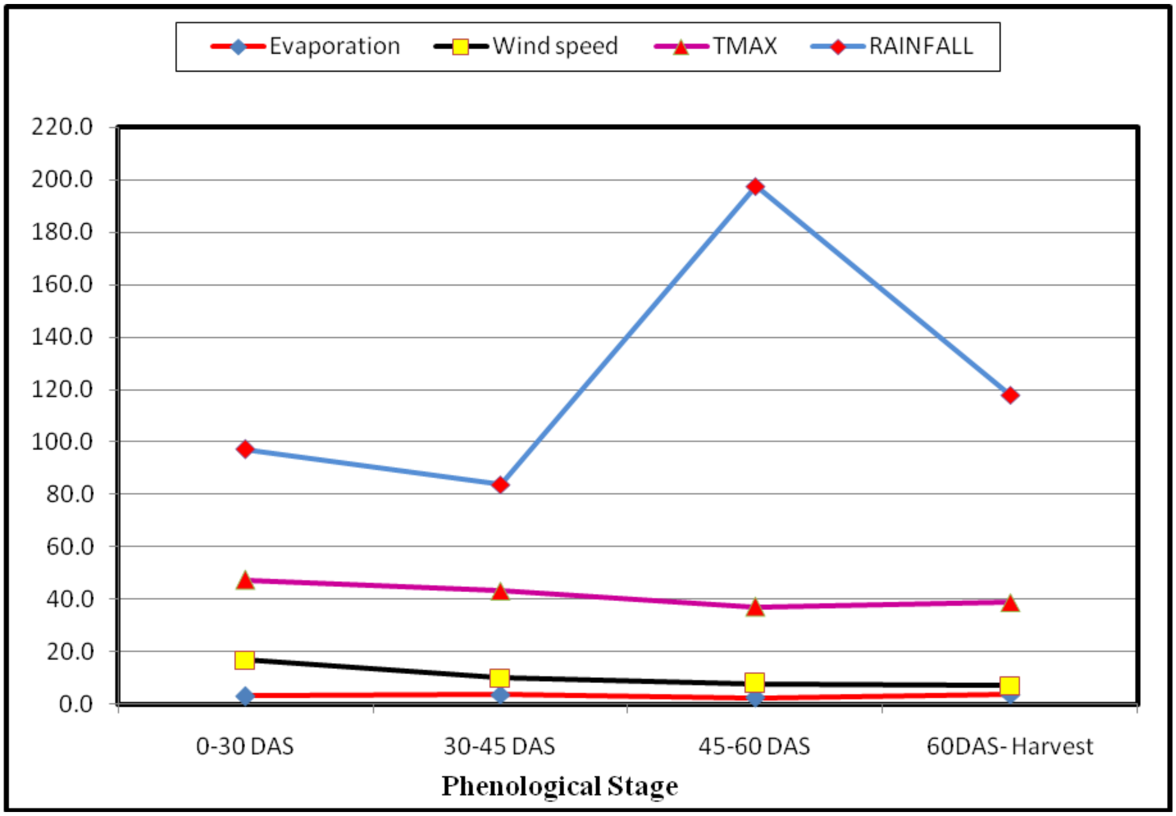

Table.1 Details of rainfall distribution and wet and dry spells during crop growth period

Crop growth period	Rainfall (mm)	Rainy Days	Dry spells (<20 mm of weekly rainfall)	Wet spell (≥20 mm of weekly rainfall)
Week before sowing	64	2	--	--
0-30 DAS	49.8	7	4	--
30-45 DAS	40.5	5	1	1
45-60 DAS	160.4	6	1	1
60 DAS- harvest	79.0	6	5	1
Total	**393.7**	**26**	**11**	**3**

Table.2 Quality parameters and yield of rainfed sunflower under integrated nutrient management practices in alfisols

Treatment	Oil content (%)	Oil yield (kg ha^{-1})	Protein Content (%)	Protein yield (kg ha^{-1})	Volume weight (g/50ml)	Hull content %	Seed yield (kg ha^{-1})
Main plot - Nutrient management practices (M)							
M_1- 0 (control)	40.08	286	11.44	82	25.37	27.90	712
M_2- Compost @ 2.5 t ha^{-1}	39.53	319	11.60	93	25.76	24.67	807
M_3- Compost @ 5.0 t ha^{-1}	40.38	386	11.50	110	26.05	24.27	955
M_4- RDF alone (60:60:30 N, P_2O_5 and K_2O Kg ha^{-1})	38.04	420	12.19	135	26.59	23.83	1104
M_5- RDF + Compost @ 2.5 t ha^{-1}	40.45	695	12.04	206	26.53	23.67	1716
M_6- RDF + Compost @ 5.0 t ha^{-1}	39.87	741	12.01	224	27.36	23.39	1859
SEm ±	0.55	27	0.26	8.49	0.71	1.93	55
C.D (P=0.05%)	NS	85	NS	26.74	NS	NS	174
Sub plot - Humic acid (S)							
S_1- 5.0 kg ha^{-1}	39.82	457	11.73	136	26.3	24.86	1147
S_2- 10.0 kg ha^{-1}	39.41	469	11.86	142	26.4	24.71	1184
S_3- 15.0 kg ha^{-1}	39.94	497	11.80	147	26.0	24.29	1244
SEm ±	0.19	14	0.25	6.03	0.24	2.69	35
C.D (P=0.05%)	NS	NS	NS	NS	NS	NS	NS
Interaction of (M X S)							
Sub at same or different level of Main							
SEm±	0.46	32	0.62	14.77	0.58	6.58	1.87
C.D (P=0.05%)	NS	NS	NS	NS	NS	NS	NS
Main at same level of Sub							
SEm ±	0.81	43	0.51	14.73	1.06	4.68	1.95
C.D (P=0.05%)	NS	NS	NS	NS	NS	NS	NS

While there was a gradual increase in the maximum temperatures (31.8 ^{0}C) and evaporation (3.7 mm day^{-1}) at the later stage (seed development to maturity) with a relatively lower rainfall (79.0 mm). the fluctuations in these weather parameters was also due to the coincidence of long dry spells (5) during initial and later stages wherein again there was a continuous dry spell (6) as evident from the respective data.

The effect of weather parameters in addition to the soil moisture availability on yield as affected by the nutrient management practices, application of varying levels of humic acid and their interaction are explained in Table 2.

Oil content (%)

The data on oil content (Table 2) revealed that there were no significant differences observed in terms of oil content (%) due to different nutrient management practices and levels of humic acid.

The interaction effect was also found to be non-significant on oil content.

Oil yield (kg ha^{-1})

The data pertaining to oil yield (Table 2) revealed that there were significant differences in oil yield due to different nutrient management practices. Among the treatments M_6 (741 kg ha^{-1}) and M_5 (695 kg ha^{-1}) recorded significantly higher oil yield over all other treatments but they were in turn comparable with each other. The lowest oil yield (286 kg ha^{-1}) was recorded under M_1 (Control).

There were no significant differences in oil yield due to varying levels of humic acid and the interaction effect was also found to be non-significant.

Oil yield is the product of oil content and seed yield. Higher seed yield under the treatments M_6 and M_5 resulted in significantly higher oil yield over rest of the treatments.

Protein content (%)

Protein content was not significantly influenced by nutrient management practices as well as varying levels of humic acid as evident from the data (Table 2).

Further, the interaction effect was also found to be non-significant on protein content.

Protein yield (kg ha^{-1})

Data on protein yield (Table 2) revealed that among the treatments M_6 and M_5 recorded significantly higher protein yield (224 and 206 kg ha^{-1}) over all other treatments but they were comparable with each other.

Among the treatments M_1 (Control) recorded the lowest protein yield (82 kg ha^{-1}).

There were no significant differences observed in terms of protein yield due to varying levels of the humic acid. The interaction effect was also found to be non-significant on protein yield.

Volume weight (g/50 ml)

Among different nutrient management practices, higher volume weight was recorded under M_6 (27.36 g/ 50 ml) Table 2.

Hull content (%)

From the data on hull content (%) (Table 2) as influenced by nutrient management practices, it is clear that M_6 recorded the minimum hull content (23.39 %), while the maximum hull content (27.90 %) was recorded in control (M_1) but the data found to be non-significant.

Data pertaining to hull content as influenced by varying levels of humic acid and interaction effect was also found to be non-significant.

Yield

The data on yield (Table 2) revealed that RDF + compost @ 5.0 t ha^{-1} (1859, 3555, 741 kg ha^{-1}

and 26.30 %) and M_5 -RDF + compost @ 2.5 t ha^{-1} (1716, 3453, 695 kg ha^{-1} and 25.66 %) recorded significantly higher seed, stalk, oil yield and harvest index over other treatments but they were in turn comparable with each other. Lower seed yield was recorded with control (M_1).

Increase in yield due to the combined application of RDF + compost @ 5 t ha^{-1} (M_6) and RDF + compost @ 2.5 t ha^{-1} (M_5) was due to the effect of immediate availability of nitrogen from inorganic source (top dressing at critical stages 30 and 60 DAS) during seedling, vegetative and reproductive stage in addition to the slow release of nutrient ions including nitrogen from compost during subsequent period of growth and development, with mineralization of organic manures, which helps in maintaining continuous availability of nutrients throughout the life cycle of sunflower crop (Gudade *et al.*, 2010 and Faisul *et al.*, 2013).

There were no significant differences in seed yield due to varying levels of humic acid and the interaction effect was found to be non-significant.

From the present investigation, it can be concluded that under rainfed conditions during a drought year, combined application of RDF (60-60-30 N, P_2O_5 and K_2O kg ha^{-1}) + compost @ 2.5 t ha^{-1} t proved superior and resulted seed yield, oil and protein, volume weight and hull content of sunflower.

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