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Original Research Article

Influence of Integrated Nutrient Management on Growth, Yield, Quality and Economics of Sunflower (*Helianthus annuus* L.)

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Integrated nutrient management, *Helianthu annuus* L.

A B S T R A C T

The field experiment was conducted during *kharif* season of 2016-2017 on vertisol soil at Oilseeds Research Station, Latur to study the **"**Influence of integrated nutrient management on growth and yield of sunflower (*Helianthus annuus* L.) in *kharif* season ". The experimental field was leveled and well drained. The soil was clayey in texture, low in available nitrogen (124.77 kg ha^{-1}), and medium in phosphorus (9.45 kg ha^{-1}) and rich in available potassium (428.03 kg ha^{-1}).The soil was alkaline in reaction having soil pH (8.0). Result revealed that the application of 100 % RDF + FYM @ 5 t/ha (T_2) recorded the highest plant height (193.67 cm), no. of functional leaves (25.08), head diameter (19.75 cm), stem girth (9.14 cm), oil yield (697 kg ha^{-1}), oil content (37.36 %), seed yield (1866 kg ha^{-1}), with net monetary return (` 32527) and B: C ratio (1.84).

Introduction

The cultivated sunflower (*Helianthus annuus* L.) is an annual oilseed plant of composite family. Sunflower is one of the fastest growing oilseeds in India. India has the fourth largest area under sunflower (18.12 million ha.) **(**Anonymous 2014-15**)** in the world. Karnataka is the largest sunflower producing state in the country. It accounts for more than half of the total area under the crop and 43 % of the total output. Andhra Pradesh is the second largest sunflower producing state. About a quarter of the total area under sunflower and 34 % output is in Andhra Pradesh. Maharashtra rank third in sunflower area as well as in production. Sunflower (*Helianthus annuus* L.) holds great promise as an oil seed crop because of it is also a crop of choice for farmers due to its wider adaptability, high yield potential, shorter duration and profitability. Wild adaptability to different agro-climatic regions and soil types. Due to that this crop play's very important role in contingency crop planning also, sunflower can play an important role in meeting out the shortage of edible oil in country. Our country is facing acute shortage of edible oil mainly because of heavy demand due to population pressure, high standard of living and high demand from oil consuming industries. This demand is partly met by import of edible oils. Under such situation it needs to build up self-sufficiency in oil production and to meet the increasing demand of consumers.

The present level of fertilizer production in India is not enough to meet the total plant nutrient requirement. The continuous use of high level of chemical fertilizers is adversely affecting the sustainability of agriculture production and causing environmental pollution. In coming decades a major issue in designing sustainable agriculture system will be the management of soil organic matter and the rational use of organic input such as animal manure, crop residues and green manure. However, since organic manure cannot meet the total nutrient needs of modern agriculture.

Integrated use of nutrient from fertilizer and organic manure sources seems to be need of the time. The basic concept underlying the integrated nutrient management system (INM) nevertheless is the maintenance of yield stability in most agro ecoregions through correction of marginal deficiency of secondary nutrients and micronutrients enhancing efficiency of applied nutrients and providing favorable soil physical conditions. The interaction of organic sources of nutrients in integrated nutrient supply and management have provided superior to the use of its each component separately.

Integrated and balanced use of nutrients through inorganic and organic sources of fertilizer is per-requisite to sustain soil fertility, supply of nutrients to optimum level and to produce maximum crop yield with minimum inputs.

The farm yard manure (FYM) contain all the essential plant nutrients and gives steady supply of these nutrients during entire crop period, leading to better growth and development of yield attributes, the higher values of growth and yield attributes consequently resulted in increased seed and straw yields.

The beneficial effect of farm yard manure (FYM), Soybean residue in improving soil fertility as well as production is well than other the nutrient sources. It also supplies plant growth promoting substances, humus forming microbes and N fixing microbes in the soil which is very much essential for sustaining the soil health as well as its yield potential. Farm yard manure (FYM) contain 0.5 % N, 0.2 % P and 0.5 % K which has very crucial importance in sustaining the soil health as well as yield potential for achieving the self-sufficiency in sunflower production in India.

Application of chemical fertilizers alone has led to environmental pollution and deterioration of soil health, use of nutrients through organic sources has been found to improve the soil health, water retaining capacity, release of plant nutrients, and increase microbial activity in soil.

Effects of Chemical fertilization on sunflower yield and quality have come under scientific scrutiny, because N is a major nutrient for plant helps in increasing total biomass production and yield. Phosphorus is necessary to increase oil content and potash helps to grain filling and disease resistant. Sulphur is an essential secondary plant nutrient and plays a vital role in improving yield and quality of oilseed crops.

Materials and Methods

The field experiment was conducted during 2016-2017 on vertisol at Oilseeds Research Station, Latur to study the influence of integrated nutrient management on growth and yield of sunflower (*Helianthus annuus* L.). The topography of experimental field was uniform and leveled. The soil was clayey in texture, low in available nitrogen (124.77 kg ha^{-1}), medium in phosphorus

(9.45 kg ha^{-1}) and very high in available potassium (428.03 kg ha^{-1}) and alkaline in nature having soil pH 8.0. The adequate amount of rainfall during period of experiment was sufficient for significant for growth and development of sunflower crop which result in significantly higher yield. Overall the thermo-aero-hydro-dynamic properties during crop season were also favorable for physiological activities of crop and its phenophysic development.

The experiment was laid out in a Randomized Block Design with nine treatments replicated thrice. T_1 -100 % RDF + SR @ 5 t/ha, T_2 -100 % RDF + FYM @ 5 t/ha, T_3 -100 % RDF + SR @ 2.5 t + FYM @ 2.5 t/ha, T_4-75 % RDF + SR @ 5 t/ha, T_5-75 % RDF + FYM @ 5 t/ha, T_6-75 % RDF + SR @ 2.5 t + FYM @ 2.5 t/ha, T_7-SR @ 5 t/ha, T_8-FYM @ 5 t/ha and T_9-SR @ 2.5 t + FYM @ 2.5 t/ha. The gross and net plot size of each experimental unit was 5.4 m x 4.5 m and 4.2 m x 3.9 m respectively. the sowing was done by dibbling method on 23 july 2016. The recommended cultu ral practices and plant protection measures were also taken as per the recommendation.

Results and Discussion

Growth parameter

The data on plant height, Dry matter production, Leaf area index, Relative growth rate are presented in table 1. and was significantly influenced due to the integrated application of organi and inorganic sources of nutrients at various growth stages.

Plant height

The effect of different treatments on plant height was found to be significant and the higher plant height was recorded with the integrated application of 100% RDF + FYM@ 5 t ha^{-1} which was found at par with T_1 -100 % RDF + SR @ 5 t/ha, T_3 -100 % RDF + SR @ 2.5 t + FYM @ 2.5 t/ha, T_5-75 % RDF + FYM @ 5 t/ha, T_6-75 % RDF + SR @ 2.5 t + FYM @ 2.5 t/ha, and significantly superior over rest of the treatments. A similar kind of result was reported by Nanjundappa *et al.,* (2001).

Stem girth (cm)

From the data on mean stem girth (cm) $plant^{-1}$ of sunflower it was revealed that the effect of different treatment on mean stem girth per plant was found significant at all the crop growth stages expect 15 and 30 DAS. The mean stem girth increased up to 75 days and later on decreased at harvest stage due to shrinkage of stem. Application of 100 % RDF + FYM @ 5 t/ha (T_2) recorded significantly highest stem girth $plant^{-1}$ (9.63 cm) of sunflower which was found at par with application of 100 % RDF + SR @ 5 t/ha (T_1), 100 % RDF + SR @ 2.5 t/ha + FYM @ 2.5 t/ha (T_3) and was significantly superior over the rest of the treatments. Similar results were also observed by Reddy *et al.,* (2009).

Head diameter (cm)

It is clear from the data on mean head diameter $plant^{-1}$ (cm) recorded periodically from 60 days after sowing till the harvest of crop.

The results revealed that the effect of different treatments on head diameter per plant (cm) of sunflower crop was found significant at all growth stages. The application of 100 % RDF + FYM @ 5 t/ha (T_2) recorded higher head diameter $plant^{-1}$ (19.75 cm $plant^{-1}$) which was found at par with application of 100 % RDF + SR @ 5 t/ha (T_1), 100 % RDF + SR @ 2.5 t/ha + FYM @ 2.5 t/ha (T_3), 75 % RDF + FYM @

2.5 t/ha (T_5) and 75 % RDF + SR @ 2.5 t/ha + FYM @ 2.5 t/ha (T_6) and was found significantly superior over rest of the treatments. These finding were in confirmative with those reported by Nanjundappa *et al.,* (2001) and Byrareddy *et al.,* (2007).

50% Flowering

Data presented in Table 7 . r evealed that treatments were differed significantly with each other in respect of flowering time.

The 50% early flowering was observes early than other treatments with application of 100 % RDF + FYM @ 5 t/ha (T_2) which found significantly better for early flowering and at par with application of 100 % RDF + SR @ 5 t/ha, (T_1), 100 % RDF + SR @ 2.5 t/ha + FYM @ 2.5 t/ha (T_3) and 75 % RDF + FYM @ 5 t/ha (T_5) which recorded significantly superior for early flowering than rest of treatments.

Dry matter

Total dry matter plant^{-1} (g) was the resultant of photosynthetic activity and its photo morphogenesis. The presented data revealed that the mean total dry matter plant^{-1} was influenced significantly due to different treatments at all crop growth stages, except 15 and 30 DAS. Application 100 % RDF + FYM @ 5 t/ha (T_2) recorded higher dry matter plant^{-1} at harvest (132.67 g) which was found significant due to the availability of readily available of all essential nutrients i.e. (organic and inorganic) for rapid initial growth and cumulative improvement in dry matter plant^{-1}. and found at par with application of 100 % RDF + SR @ 5 t/ha (T_1), 100 % RDF + SR @ 2.5 t/ha + FYM @ 2.5 t/ha (T_3) and significantly superior over rest of treatments. Similar results were observed by Nanjundappa *et al.,* (2001).

Yield parameter

The yield contributory parameter such as Seed yield kg plant $^{-1}$ Biological yield (kg/ha), Stalk yield (kg ha^{-1}), Test weight (g) and Harvest index (%) were significantly influenced with the integrated application of different treatments.

Seed yield kg ha^{-1}

The mean seed yield (kg/ha) was recorded 1332 kg/ha. Effect of different treatments on seed yield was found to be significant. The highest seed yield (1866 kg/ha) was recorded with the application of 100 % RDF + FYM @ 5 t/ha (T_2) which found at par with treatment 100 % RDF + SR @ 5 t/ha (T_1), 100 % RDF + SR @ 2.5 t/ha + FYM @ 2.5 t/ha (T_3) and was found significantly superior over rest of the treatment. These finding were in confirmative with those reported by Nanjundappa *et al.,* (2001).

Stalk yield kg ha^{-1}

The yield contributing character viz., stalk yield was influenced significantly by various treatments.

The application of 100 % RDF + FYM @ 5 t/ha (T_2) was recorded more stalk yield (5345 kg/ha) which found at par with treatment 100 % RDF + SR @ 5 t/ha (T_1), 100 % RDF + SR @ 2.5 t/ha + FYM @ 2.5 t/ha (T_3), 75 % RDF + FYM @ 2.5 t/ha (T_5) and 75 % RDF + SR @ 2.5 t/ha + FYM @ 2.5 t/ha (T_6) and was significantly superior over rest of the treatment. Whereas, application of SR @ 5 t/ha (T_7) recorded lowest stalk yield (2498 kg/ha).

Biological yield kg ha^{-1}

Biological yield was significantly influenced by different treatments.

Table.1 Growth parameters as influenced by integrated nutrient management in sunflower

Treatments	Plant height (cm)	Stem girth (cm)	Head diameter (cm)	50% Flowering	Dry matter
T_1- 100 % RDF + SR @ 5 t/ha	185.27	8.74	18.32	50.00	126.07
T_2- 100 % RDF + FYM @ 5 t/ha	193.67	9.63	19.75	46.00	132.67
T_3- 100 % RDF + SR @ 2.5 t + FYM @2.5 t/ha	191.11	9.19	19.40	48.67	130.00
T_4- 75 % RDF + SR @ 5 t/ha	173.67	7.64	17.31	57.33	96.00
T_5- 75 % RDF + FYM @ 5 t/ha	183.37	8.20	18.13	53.00	112.17
T_6- 75 % RDF + SR @ 2.5 t + FYM@ 2.5 t/ha	176.87	8.02	17.62	55.33	99.13
T_7- Soybean residue @ 5 t/ha	164.73	7.36	13.05	62.67	90.64
T_8- FYM @ 5 t/ha	172.23	7.62	15.48	58.33	95.55
T_9- SR @ 2.5 t + FYM @ 2.5 t/ha	168.93	7.57	15.37	60.00	93.00
SEm±	6.23	0.41	0.78	2.719	4.77
C.D. at 5%	18.66	1.22	2.34	8.150	14.31
General Mean	**178.87**	**8.22**	**17.16**	**54.59**	**108.36**

Table.2 Yield parameters as influenced by integrated nutrient management in sunflower

Treatments	Seed yield kg ha^{-1}	Stalk yield kg ha^{-1}	Biological yield kg ha^{-1}	Test weight (1000 seed weight g)	Harvest index (%)
T_1- 100 % RDF + SR @ 5 t/ha	1700	5201	6901	48.27	24.63
T_2- 100 % RDF + FYM @ 5 t/ha	1866	5345	7211	48.70	25.87
T_3- 100 % RDF + SR @ 2.5 t + FYM @2.5 t/ha	1766	5243	7009	48.30	25.19
T_4- 75 % RDF + SR @ 5 t/ha	1320	4399	5719	47.19	23.08
T_5- 75 % RDF + FYM @ 5 t/ha	1521	4978	6498	48.23	23.40
T_6- 75 % RDF + SR @ 2.5 t + FYM @ 2.5 t/ha	1411	4648	6059	48.19	23.28
T_7- Soybean residue @ 5 t/ha	710	2498	3208	47.07	22.13
T_8- FYM @ 5 t/ha	860	2905	3765	47.15	22.84
T_9- SR @ 2.5 t + FYM @ 2.5 t/ha	831	2888	3719	47.11	22.34
SEm±	80	311	261	72.0	-
C.D. at 5%	240	931	783	NS	-
General Mean	**1332**	**4234**	**5566**	**47.80**	**23.64**

Table.3 Effect of integrated nutrient management on quality and economics of sunflower

Treatments	**Gross monetary return (`)**	**Net monetary return (`)**	**B: C ratio**	**Oil content (%)**	**Oil yield (kg ha^{-1})**
T_1- 100 % RDF + SR @ 5 t/ha	64600	27469	1.73	36.15	615
T_2- 100 % RDF + FYM @ 5 t/ha	70908	32527	1.84	37.36	697
T_3- 100 % RDF + SR @ 2.5 t + FYM@ 2.5 t/ha	67108	29352	1.77	36.94	652
T_4- 75 % RDF + SR @ 5 t/ha	50160	17083	1.51	33.91	448
T_5- 75 % RDF + FYM @ 5 t/ha	57798	23471	1.68	35.73	543
T_6- 75 % RDF + SR @ 2.5 t + FYM@ 2.5 t/ha	53618	19916	1.59	34.52	487
T_7- Soybean residue @ 5 t/ha	26980	6078	1.29	32.02	227
T_8- FYM @ 5 t/ha	32680	10528	1.47	33.49	288
T_9- SR @ 2.5 t + FYM @ 2.5 t/ha	31578	10051	1.46	32.85	273
SEm±	3042	3042	-	2.01	24
C.D. at 5%	9119	9119	-	NS	70
General Mean	**50603**	**19331**	**1.59**	**34.77**	**470**

Application of treatment 100 % RDF + FYM @ 5 t/ha (T_2) produced highest biological yield which was at par with treatment 100% RDF + SR @ 5 t/ha (T_1), 100 % RDF + SR @ 2.5 t/ha + FYM @ 2.5 t/ha (T_3) and 75 % RDF + FYM @ 5 t/ha (T_5). and was found significantly superior over the rest of the treatments.

Test weight (1000 seed weight g)

The data on mean Test weight (g) are presented in Table 2. The mean Test weight (g) was 47.80 (g).

Effect of different treatments on Test weight (g) was found to be non-significant. However the highest Test weight (48.70 g) was recorded with the application100 % RDF + FYM @ 5 t/ha (T_2) whereas, the lowest test weight (47.07 g) was recorded in treatment T_7 i.e. SR @ 5 t/ha.

Harvest index (%)

The higher harvest index (25.87 %) was recorded with the application of treatment 100 % RDF+ FYM @ 5 t/ha (T_2) fallowed by application of 100 % RDF + SR @ 2.5 t/ha + FYM @ 2.5 t/ha (T_3) the lowest harvest index was recorded with treatment T_7 i.e. application of SR @ 5 t/ha.

Economics

The Gross monetary return, net monetary return and benefit cost ratio of different treatments are depicted in Table 3.

Gross monetary return

Data pertaining to the gross monetary return (GMR) as influenced by various treatments are presented in Table 3. The mean gross monetary return of sunflower was recorded as (` 50603 ha^{-1}).

The gross monetary return was differed significantly due to different treatments. The significantly highest gross monetary return (` 70908 ha^{-1}) was obtained with the application of 100 % RDF + FYM @ 5 t/ha (T_2) which was found at par with application of 100 % RDF + SR @ 5 t/ha (T_1), 100 % RDF + SR @ 2.5 t/ha + FYM @ 2.5 t/ha (T_3) and significantly superior over rest of the treatments.

Net monetary return

Data on net monetary return (` ha-1) as influenced by various treatments are presented in Table 3. The mean net monetary return was recorded as (` 19331 ha-1). The net monetary return (`` 19331/ha) of sunflower was influenced significantly due to different treatments.

Application of 100 % RDF +FYM @ 5 t/ha (T2) recorded significantly higher net monetary return (` 32527 ha-1). which was found at par with application of 100 % RDF + SR @ 5 t/ha (T1), 100 % RDF + SR @ 2.5 t/ha + FYM @ 2.5 t/ha (T3), 75 % RDF + FYM @ 5 t/ha (T5) and which was significantly superior over rest of the treatments.

Benefit: Cost ratio

Data in respect of B: C ratios of different treatments as influenced by various treatments are presented in Table 3. The mean benefit: cost ratio was recorded as 1.59.

The higher benefit: cost ratio (1.84) was recorded with application of 100 % RDF + FYM @ 5 t/ha (T2) followed by 100 % RDF + SR @ 2.5 t/ha + FYM @ 2.5 t/ha (T3). The lowest B: C ratio (1.29) was recorded by treatment (T7) i.e. application of SR @ 5 t/ha.

Quality

Oil content (%)

Oil content (%) was not influenced significantly by different treatments. As the oil yield is the function of seed yield and oil content in seed, the maximum oil yield (697 kg/ha) was recorded with the application of 100 % RDF + FYM @ 5 t/ha (T_2) which found at par with application of 100 @ RDF + SR @ 2.5 t/ha + FYM @ 2.5 t/ha (T_3) and found significantly superior over rest of treatments. These results are in confirmative with the findings of Shrikant Chitale *et al.*, (2004).

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