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Response of Sunflower to Different Integrated Nutrient Management Practices in Nagaland

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ABSTRACT: Background: A pot experiment was carried out during pre-kharif season (March-June) of 2022 in Agronomy Department of School of Agricultural Sciences, Nagaland University to study the effect of integrated nutrient management on growth, yield and quality of Sunflower.

Method: The experiment was laid out in Completely Randomized Design (CRD) with 7 treatments and 3 replications. The treatments consisted of control, 100% RDF (60:40:60) kg ha^{-1}, FYM @ 2 t ha^{-1} + 100% RDN, FYM @ 4 t ha^{-1} + 100% RDN, FYM @ 6 t ha^{-1} + 100% RDN, FYM @ 8 t ha^{-1} + 100% RDN and FYM 10 t ha^{-1} + 100% RDN.

Results and Conclusion: The results revealed that the growth parameters *viz.*, plant height (cm), number of leaves plant^{-1}, dry weight plant^{-1} (g), leaf area plant^{-1} (cm^{-2}), crop growth rate (g m^{-2} day^{-1}) and relative growth rate (g g^{-1} day^{-1}) improved with application of FYM @ 10 t ha^{-1} + 100% RDN and was found statistically at par with 100% RDF (60:40:60) kg ha^{-1}. The yield attributes *viz.*, seed yield (g pot^{-1}), stover yield (g pot^{-1}) and harvest index (%) also improved when FYM @ 10 t ha^{-1} was applied in conjunction with 100% RDN and found comparable with 100% RDF (60:40:60) kg ha^{-1}.

Keywords: Sunflower, growth parameters, seed yield, stover yield.

INTRODUCTION

Sunflower (*Helianthus annus*) is an important oilseed crop derived from the Greek word 'helios' meaning 'sun' and 'anthos' meaning 'flower'. It is an annual plant which is native to America and probably originated in South-West Asia (Heiser, 1976). As the name itself suggest, it always follows the sun by day, always turn towards its direct rays and so has its name derived from the flower's shape and image which is often used to depict the sun. The plant has a rough, hairy stem, broad, coarsely toothed, rough leaves and circular heads of flowers. The heads consist of many individual flowers which mature into seeds on a receptacle base. Sunflower requires a cool climate during germination and seedling growth, warm weather from seedling stage up to flowering and non-cloudy, 2 sunny days during flowering to maturity. A good crop of sunflower can be taken in areas with rainfall 300-500 cm. High temperature above 38˚C during post anthesis period reduces seed yield and oil content. The crop can thrive well in a variety of soils and the optimum pH of the soil is 6.5 to 8.5. At present, the level of fertilizer production in India is not enough to meet the total plant nutrient and also the continuous usage of high leveled chemical fertilizers is adversely affecting the sustainability of agriculture production and causing environmental pollution. Integrated use of nutrients from fertilizer and organic manure sources seems to be the need of the time. Lower Sunflower productivity could be attributed to poor nutrient and water management practices since water and nutrient are the most important inputs for optimum sunflower production (Gholamhoseini *et al*., 2013). Excessive use of chemical fertilizers to enhance production not only increases the cost of production but also leads to the deterioration of soil and human health.

MATERIAL AND METHODS

The experiment was conducted in Agronomy Department of School of agricultural Science, Medziphema during pre-kharif season, 2022. It is situated at an altitude of 310 m above mean sea level with geographical location at 20° 45′43″ N latitude and 95° 53′04″ N longitudes. The climate in the experimental farm represents humid and sub-humid climate zone with high relative humidity with an average rainfall of 2000-2500 mm starting from April and ends in September while the period from October to March remains comparatively dry. Temperature during summer ranges from 21°C to 32°C and rarely goes below 8°C in winter due to high atmospheric pressure. KBSH-44: Released in the year 2002 and developed by AICRP (Sunflower) Centre, University of Agricultural Sciences, Bengaluru. The variety has an average yield of 1500-1800 kg ha^{-1} and potential yield of 2200-2800 kg ha^{-1} with a duration of 90-95 days. FYM @ 2, 4, 6, 8 and 10 t ha^{-1} were applied 15 days prior to sowing as per the dose recommended for each pot to facilitate the process of thorough decomposition

of organic nutrient supply to the crop. The manure was properly incorporated into the pots by removing a portion of the top soil in the pot to allow proper incorporation. The fertilizers NPK was applied at the rate of 60, 40 and 60 kg ha^{-1}, respectively in the form of urea, single super phosphate (SSP) and muriate of potash (MOP).The seeds were sown at a depth of 5 cm in each pot.

RESULTS AND DISCUSSION

Plant height. At 30 DAS, minimum plant height (19.48 cm) was observed in T_1 (Control) and maximum (31.67 cm) in T_7 (FYM @ 10 t ha^{-1} + 100% RDN) followed by T_2 (100% RDF (60:40:60) kg ha^{-1}) and T_6 (FYM @ 8 t ha^{-1} + 100% RDN) which were statistically at par with each other. At 60 DAS, T_7 (FYM @ 10 t ha^{-1} + 100% RDN) showed maximum plant height (124.70 cm) which was statistically at par with T_2 (100% RDF (60:40:60) kg ha^{-1}). T_2 (100% RDF (60:40:60) kg ha^{-1}) and T_6 (FYM @ 8 t ha^{-1} + 100% RDN) which were statistically at par with each other. At harvest also, minimum plant height (80.38 cm) was found in T_1 (Control) and maximum plant height (125.70 cm) was observed in T_7 (FYM @ 10 t ha^{-1} + 100% RDN) which was statistically at par with T_2 (100% RDF (60:40:60) kg ha^{-1}). The increase in plant height could be due to better crop growth facilitated by the improvement in soil physical, chemical and biological properties as well as plant nutrition with the addition of organic manure. Similar findings on positive use of FYM on plant height were reported by Byrareddy *et al*. (2008) ; Ahmad and Jabeen (2009).

Number of Leaves. At 30 DAS, minimum number of leaves (6.33) was found in T_1 (Control) whereas maximum number of leaves (12.67) was found in T_7 (FYM @ 10 t ha^{-1} + 100% RDN) which was found to be statistically at par with T_2 (100% RDF (60:40:60) kg ha^{-1}). At 60 DAS, T_7 (FYM @ 10 t ha^{-1} + 100% RDN) showed maximum number of leaves (23.73) followed by T_2 (100% RDF (60:40:60) kg ha) and T_6 (FYM @ 8 t ha^{-1} + 100% RDN). At harvest, minimum number of leaves (11.67) was found in T_1 (Control) and maximum number of leaves (20.33) was found in T_7 (FYM @ 10 t ha^{-1} + 100% RDN) which was statistically at par with T_2 (100% RDF (60:40:60) kg ha^{-1}). Increase in number of leaves might be due to high photosynthesis with the combined application of fertilizers and FYM. Similar findings on integrated use of manures and fertilizers were reported by Byrareddy *et al*. (2008).

Dry weight Plant^{-1}. T1 (Control) showed lowest dry weight plant^{-1} (3.18 g) at 30 DAS whereas T_7 (FYM @ 10 t ha^{-1} + 100% RDN) showed highest dry weight plant^{-1} (8.11 g) which was statistically at par with treatment T_2 (100% RDF (60:40:60) kg ha^{-1}). At 60 DAS and at harvest, minimum dry weight plant^{-1} (31.98 g, 32.53 g, respectively) was found in T_1 (Control) whereas maximum dry weight plant^{-1} (73.71 g, 75 g, respectively) was found in T_7 (FYM @ 10 t ha^{-1} + 100% RDN) which were statistically at par with T_2 (100% RDF (60:40:60) kg ha^{-1}). Application of FYM along with nitrogen helped to improve of physical, chemical and biological properties of soil which helped in better nutrition to plant and thus finally produced more dry weight. Similar were the findings of Dordas and Sioulas (2009).

Leaf area Plant^{-1}. At 30 and 60 DAS minimum leaf area plant^{-1} (49.92 cm^{-2}, 94.46 cm^{-2}, respectively) was found in T_1 (Control) whereas maximum leaf area plant^{-1} (64.09 cm^{-2}, 162.47 cm^{-2}, respectively) was observed in T_7 (FYM @ 10 t ha^{-1} + 100% RDN). However, at 30 DAS, T_2 {100% RDF (60:40:60) kg ha^{-1}} and T_6 (FYM @ 8 t ha^{-1} + 100% RDN) were found to be statistically at par with each other. At 60 DAS, T_7, T_2 and T_6 were statistically at par with each other. As compared to control, more leaf area plant^{-1} was recorded in all the treatments where FYM was applied along with 100% RDN and 100% RDF because of good supply of all essential nutrients to the plant especially nitrogen which resulted in more number of cells and size of cell thus resulted in more leaf area plant^{-1}. Similar were the observations of Trapáni *et al*. (1999); Haque and Jakhro (2001).

Crop growth rate. Crop growth rate from 30-60 DAS was more as compared to 60-harvest due to senescence of plants occurring at later stages. However, among different treatments at 30-60 DAS, minimum CGR (10 g m^{-2} day^{-1}) was found in T_1 (Control) and maximum (22.78 g m^{-2} day^{-1}) was recorded in T_7 (FYM @ 10 t ha^{-1}+ 100% RDN) which was statistically at par with T_2 {100% RDF (60:40:60) kg ha^{-1}}. At 60-harvest, minimum CGR (0.18 g m^{-2} day^{-1}) was recorded in T_1 (Control) and maximum (0.42 g m^{-2} day^{-1}) in T_7 (FYM @ 10 t ha^{-1} + 100% RDN). However, treatment T_7, T_2, T_6 and T_5 were found to be statistically at par with each other The improvement in CGR may be attributed to more vegetative growth due to N fertilizer application. Similar findings were reported by Chandrashekara and Patil (1997); Nkoa *et al*. (2001); Miralles *et al*. (1997).

Relative growth rate

Relative growth rate from 30-60 DAS was more as compared to 60 harvest due to senescence of plant at later stages. However, among different treatments at 30-60 DAS, minimum RGR (0.960 g g^{-1} day^{-1}) was found in T_1 (Control) and maximum (2.186 g g^{-1} day^{-1}) was recorded in T_7 (FYM @ 10 t ha^{-1} + 100% RDN) which was statistically at par with T_2 {100% RDF (60:40:60) kg ha^{-1}}. Treatments T_2, T_6 and T_5 were at par with each other. From 60-harvest, minimum RGR (0.0169 g g^{-1} day^{-1}) was recorded in T_1 (Control) and maximum (0.0403 g g^{-1} day^{-1}) in T7 (FYM @ 10 t ha^{-1} + 100% RDN). However, treatment T_7, T_2, T_6, T_5 and T_4 were statistically at par with each other. Decrease in relative growth rate could be could due to reduced uptake of nutrients and water as the roots start getting suberized after completion of active vegetative growth as reported by Russell (1952).

Yield attributes and Yield. Minimum number of seeds head^{-1} (344.67) was observed in T_1 (Control) where nutrients were not applied whereas maximum number of seeds head^{-1} (783.33) was found in T_7 (FYM @ 10 t ha^{-1} + 100% RDN) which was found to be statistically at par with the treatments T_2, T_6 and T_5. The increase in number of seeds could be due to higher amount of nutrient supplied through higher dose of FYM along with inorganic fertilizer which further increased the

availability of nutrients in soil thus allowing more uptake of nutrients and increased photosynthetic efficiency as evident from increased LAI resulted in higher head diameter size and ultimately higher number of filled seeds head^{-1}. This result is in accordance with the findings of Byrareddy *et al*. (2008); Kalaiyarasan and Vaiyapuri (2008).

There was no significant difference in test weight due to different nutrient management. This could be due to genetic constituent of variety as all the treatments were given in same variety of sunflower.

Among the different treatments, minimum seed yield (8.26 g pot^{-1}) was observed in T_1 (Control) whereas maximum (26.67 g pot^{-1}) was observed in T_7 (FYM @ 10 t ha^{-1} + 100% RDN) which was statistically at par with T_2 {100% RDF (60:40:60) kg ha^{-1}}. Increase in seed yield was observed with higher dose of FYM (10 t ha^{-1}) along with 100% RDN as compared to lower dose of FYM (2,4,6,8 t ha^{-1}) along with 100% RDN. Treatment T_2 and T_6 were statistically at par with each other. The increase in seed yield could be due to FYM being a store house of several macro and micronutrients which are released during the process of mineralization and thus stimulate the activity of microorganisms that make the plant nutrients readily available in nutrients increasing crop yields either by acceleration of respiratory process by increasing cell permeability by hormone growth action or by combination of all the processes *viz.,* release of nutrients, increasing availability of nutrients and improving soil physical, chemical and biological properties. Similar findings were reported by Nanjundappa *et al*. (2001); Manjunatha *et al*. (2009); Mohammadi *et al*. (2012).

T_1 (Control) showed minimum stover yield (23.76 g pot^{-1}) whereas maximum stover yield (48.33 g pot^{-1}) was recorded in T_7 (FYM @ 10 t ha^{-1} + 100% RDN) which was statistically at par with treatment T_2, T_6 and T_5. The increase in stover yield could be due to increase in release of nutrients supplied from both manure and inorganic fertilizer ultimately leading to increased plant height and obviously more stover yield. Similar findings were reported by Tiwari and Parihar (1992).

Highest harvest index (36.14%) was recorded in T_7 (FYM @ 10 t ha^{-1} + 100% RDN) and found statistically at par with all the remaining treatments except T_1 (Control). High harvest index where organic and inorganic sources of nutrients were used was due to supply of nutrients to the crops which resulted in higher seed yield. A similar finding was reported by Mahavishnan *et al*. (2006).

Table 1: Effect of integrated nutrient management on plant height (cm) at 30, 60 DAS and at harvest.

Plant height (cm)			
Treatment	**30 DAS**	**60 DAS**	**At harvest**
T_1 : Control	19.48	80.31	80.38
T_2 : 100% RDF (60:40:60) kg ha^{-1}	27.40	122.42	122.79
T_3 : FYM @ 2 t ha^{-1} + 100% RDN	23.03	94.39	94.53
T_4 : FYM @ 4 t ha^{-1} + 100% RDN	23.82	102.90	103.03
T_5 : FYM @ 6 t ha^{-1} + 100% RDN	24.36	111.01	111.40
T_6 : FYM @ 8 t ha^{-1} + 100% RDN	26.96	119.35	119.42
T_7 : FYM @ 10 t ha^{-1} + 100% RDN	31.67	124.70	125.70
SEm±	0.93	1.56	1.48
CD (p=0.05)	2.81	4.75	4.48

Table 2: Effect of integrated nutrient management on number of leaves plant^{-1} at 30, 60 DAS and at harvest.

Number of leaves plant^{-1}			
Treatment	**30 DAS**	**60 DAS**	**At harvest**
T_1 : Control	6.33	12.33	11.67
T_2 : 100% RDF (60:40:60) kg ha^{-1}	12.33	22.00	19.96
T_3 : FYM @ 2 t ha^{-1} + 100% RDN	9.67	16.67	12.67
T_4 : FYM @ 4 t ha^{-1} + 100 RDN	10.96	18.00	15.89
T_5 : FYM @ 6 t ha^{-1} + 100% RDN	11.26	19.68	16.15
T_6 : FYM @ 8 t ha^{-1} + 100% RDN	11.92	21.67	17.33
T_7 : FYM @ 10 t ha^{-1} + 100% RDN	12.67	23.73	20.33
SEm±	0.45	0.61	0.52
CD (p=0.05)	1.38	1.84	1.57

Table 3: Effect on integrated nutrient management on dry weight plant^{-1} (g) at 30, 60 DAS and at harvest.

Dry weight plant^{-1}(g)			
Treatment	**30 DAS**	**60 DAS**	**At harvest**
T_1 : Control	3.18	31.98	32.53
T_2 : 100% RDF (60:40:60) kg ha^{-1}	7.54	70.03	71.31
T_3 : FYM @ 2 t ha^{-1} + 100% RDN	4.31	46.48	47.88
T_4 : FYM @ 4 t ha^{-1} + 100% RDN	5.02	57.89	59.11
T_5 : FYM @ 6 t ha^{-1} + 100% RDN	6.25	65.11	66.30
T_6 : FYM @ 8 t ha^{-1} + 100% RDN	6.95	66.08	67.32
T_7 : FYM @ 10 t ha^{-1} + 100% RDN	8.11	73.71	75.00
SEm±	0.28	1.80	1.81
CD (p=0.05)	0.85	5.46	5.49

Table 4: Effect of integrated nutrient management on leaf area plant^{-1} (cm^{-2}) at 30 and 60 DAS.

Leaf area plant^{-1} (cm^{-2})		
Treatment	**30 DAS**	**60 DAS**
T_1 : Control	49.92	94.46
T_2 : 100% RDF (60:40:60) kg ha^{-1}	61.33	160.07
T_3 : FYM @ 2 t ha^{-1} + 100% RDN	55.03	146.76
T_4 : FYM @ 4 t ha^{-1} + 100% RDN	56.36	151.36
T_5 : FYM @ 6 t ha^{-1} + 100% RDN	58.38	155.36
T_6 : FYM @ 8 t ha^{-1} + 100% RDN	60.07	157.67
T_7 : FYM @ 10 t ha^{-1} + 100% RDN	64.09	162.47
SEm±	0.96	1.84
CD (p=0.05)	2.92	5.57

Table 5: Effect on integrated nutrient management on Crop Growth Rate (CGR) (g m^{-2} day^{-1}) at 30-60 DAS and 60-harvest.

Crop growth rate (g m^{-2} day^{-1})		
Treatment	**30-60 DAS**	**60-harvest**
T_1 : Control	10.00	0.18
T_2 : 100% RDF (60:40:60) kg ha^{-1}	21.70	0.41
T_3 : FYM @ 2 t ha^{-1} + 100% RDN	14.64	0.30
T_4 : FYM @ 4 t ha^{-1} + 100% RDN	18.36	0.36
T_5 : FYM @ 6 t ha^{-1} + 100% RDN	20.44	0.38
T_6 : FYM @ 8 t ha^{-1} + 100% RDN	20.53	0.39
T_7 : FYM @ 10 t ha^{-1} + 100% RDN	22.78	0.42
SEm±	0.58	0.02
CD (p=0.05)	1.74	0.07

Table 6: Effect of integrated nutrient management on Relative Growth Rate (RGR) (g g^{-1} day^{-1}) at 30-60 DAS and 60-harvest.

Relative growth rate (g g^{-1} day^{-1})		
Treatment	**30-60 DAS**	**60-harvest**
T_1 : Control	0.960	0.017
T_2 : 100% RDF (60:40:60) kg ha^{-1}	2.083	0.039
T_3 : FYM @ 2 t ha^{-1} + 100% RDN	1.406	0.029
T_4 : FYM @ 4 t ha^{-1} + 100% RDN	1.762	0.035
T_5 : FYM @ 6 t ha^{-1} + 100% RDN	1.962	0.037
T_6 : FYM @ 8 t ha^{-1} + 100% RDN	1.971	0.038
T_7 : FYM @ 10 t ha^{-1} + 100% RDN	2.186	0.040
SEm±	0.06	0.002
CD (p=0.05)	0.17	0.007

Table 7: Effect of integrated nutrient management on head diameter (cm) and number of seeds head^{-1}, test weight (g).

Treatment	Head diameter (cm)	No. of seeds head^{-1}	Test weight (g)
T_1 : Control	9.03	344.67	2.46
T_2 : 100% RDF (60:40:60) kg ha^{-1}	14.27	762.67	3.24
T_3 : FYM @ 2 t ha^{-1} + 100% RDN	12.30	530.00	3.03
T_4 : FYM @ 4 t ha^{-1} + 100% RDN	13.23	646.33	3.08
T_5 : FYM @ 6 t ha^{-1} + 100% RDN	13.40	728.67	3.10
T_6 : FYM @ 8 t ha^{-1} + 100% RDN	13.63	734.33	3.14
T_7 : FYM @ 10 t ha^{-1} + 100% RDN	14.50	783.33	3.41
SEm±	0.50	27.79	0.18
CD (p=0.05)	1.53	84.29	NS

Table 8: Effect of integrated nutrient management on seed yield (g pot^{-1}), stover yield (g pot^{-1}) and harvest index (%).

Treatment	Seed yield (g pot^{-1})	Stover yield (g pot^{-1})	Harvest index (%)
T_1 : Control	8.26	23.76	25.93
T_2 : 100% RDF (60:40:60) kg ha^{-1}	24.66	46.65	34.77
T_3 : FYM @ 2 t ha^{-1} + 100% RDN	16.08	31.68	33.68
T_4 : FYM @ 4 t ha^{-1} + 100% RDN	19.93	39.18	33.85
T_5 : FYM @ 6 t ha^{-1} + 100% RDN	21.79	43.98	33.93
T_6 : FYM @ 8 t ha^{-1} + 100% RDN	23.08	44.62	34.09
T_7 : FYM @ 10 t ha^{-1} + 100% RDN	26.67	48.33	36.14
SEm±	0.84	2.03	1.95
CD (p=0.05)	2.56	6.16	5.90

CONCLUSIONS

The highest plant height (cm) was recorded in T_7 (FYM 10 t ha^{-1} + 100% RDN) at all crop growing stages *i.e.,* 30, 60 DAS and at harvest with values 31.67cm, 124.70 cm and 125.70 cm, respectively. T_7 (FYM 10 t ha^{-1} + 100% RDN) gave the maximum number of leaves $plant^{-1}$ at 30, 60 DAS and at harvest with 12.67, 23.73 and 20.33, respectively. Maximum dry weight $plant^{-1}$ (g) was recorded in T_7 (FYM 10 t ha^{-1} + 100% RDN) at 30, 60 DAS and at harvest with values 8.11 g, 73.71 g and 75 g, respectively. Maximum Leaf area $plant^{-1}$ (cm^{-2}) was observed at 30 and 60 DAS in T_7 (FYM @ 10 t ha^{-1} + 100% RDN) having values 64.09 cm^{-2} and 162.47 cm^{-2}, respectively. For Crop Growth Rate (CGR), T_7 (FYM 10 t ha^{-1} + 100% RDN) recorded highest at both intervals 30-60 DAS and 60-harvest with values 22.78 g m^{-2} day^{-1} and 0.42 g m^{-2} day^{-1}, respectively. Relative Growth rate (RGR) was higher at both intervals 30-60 DAS and 60-harvest in T_7 (FYM 10 t ha^{-1} + 100% RDN) with values 2.186 g g^{-1} day^{-1} and 0.0403 g g^{-1} day^{-1}, respectively. There was no significant influence in days to 50% flowering and days to maturity due to different treatments. T_7 (FYM 10 t ha^{-1} + 100% RDN) recorded highest in yield attributing characters *i.e.,* head diameter (14.50 cm), number of seeds $head^{-1}$ (783.33), seed yield (26.67 g pot^{-1}) and stover yield (48.33 g pot^{-1}). However, there was no significant effect on test weight due to different treatments. Highest harvest index (%) was recorded in T_7 (FYM 10 t ha^{-1} + 100% RDN) having value 36.14%.

FUTURE SCOPE

The present study was conducted for one year only. By doing long-term experiment, we can get more accurate and precise results.

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Conflict of Interest. None.

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