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Growth and Yield of Sunflower as Influenced by Nutrient Management Practices

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A B S T R A C T

A field experiment was conducted during the year 2013 to study the effect of nutrient management practices on growth and yield of hybrid sunflower (cv. RSFH 130) in split plot design on medium deep black soil under protective irrigation at Agricultural Research Station, Hagari, Ballari, University of Agricultural Sciences, Raichur, Karnataka. Treatments consisted of four main plot treatments; different nutrient management practices through soil application *viz.*, M_1; application of RDF (90:90:60 kg N, P_2O_5, K_2O /ha), M_2; application of RDF + FYM @ 8 t/ha, M_3; application of 85 % RDF + FYM @ 8 t/ha and M_4; application of 60 % RDF + FYM @ 8 t/ha and four sub plot treatments; nutrient management practices through water soluble foliar grade fertilizers *viz.*, S_1; control, S_2; foliar application of 19:19:19 water soluble foliar grade fertilizer @ 2% at 25 and 40 DAS, S_3; foliar application of 17:44 water soluble foliar grade fertilizer @ 2% at 25 and 40 DAS and S_4; foliar application of urea @ 2% at 25 and 40 DAS. Results revealed that application of RDF + FYM @ 8 t/ha along with foliar application of 19:19:19 water soluble foliar grade fertilizer @ 2% at 25 and 40 DAS recorded higher plant height, stem girth, total dry matter production, head diameter, seed yield per plant, thousand seed weight, seed yield, stalk yield, oil content and oil yield of sunflower when compared to other treatment combinations.

Introduction

In India sunflower emerged as a promising potential oilseed crop in seventies because of its special characteristics *viz.*, wider adaptability to varied climatic conditions, photo insensitivity, low seed rate, high yield potential, short duration, response to applied

nutrients and high quality oil. In India sunflower is grown over an area of 0.55 million hectares with a production of 0.42 million tonnes and a productivity of 753 kg ha^{-1} (Anon, 2016) which is far below than its potential. Karnataka accounts majority of the sunflower production (0.21 million tonnes) in India with an area of 0.36 million hectares and productivity of 597 kg ha^{-1}. The lower productivity of crop is mainly ascribed to cultivation of sunflower in less fertile marginal lands under low and uncertain rainfall situations with low and imbalanced use of fertilizers (Ramulu *et al.,* 2011).

Sunflower is an important fast growing and high yielding energy rich oilseed crop which removes considerable amount of nutrients and ranks fourth next only to soybean, groundnut and rapeseed as a source of premier quality edible oil in the world. Unless the soils are replenished with all the nutrients taken up by the crop, there will be persistent nutrient exhaustion posing a great threat to sustainable production and in turn puts heavy demand on soil and applied nutrients (Hegde, and Sudhakarababu, 2009). Sunflower has a high nitrogen requirement that must be supplied throughout its growth and a shortage of nitrogen prior to flower initiation reduces the yield. Phosphorus is the second major nutrient after nitrogen in limiting the sunflower production as phosphorus is more prone for fixation rendering it as non available to plants due to many soil reactions and interactions with other elements. Further, Biradar *et al.,* (2012) indicated wide variation in the current nutrient management practices and nutrient levels for obtaining potential yields. The research efforts made in respect to its nutritional requirements are scanty and imbalanced use of fertilizers has been identified as one of the critical constraints in sunflower production. Farmyard manure/organic manures combined with inorganic fertilizer management resulted in a higher increase in sunflower yield, Therefore, nutrient management in sunflower assumes importance for increasing productivity. Thus, an experiment was conducted to study the effect of different nutrient management practices on growth, yield and quality of sunflower.

Materials and Methods

Field experiment was conducted during post rainy season of 2013 at Agricultural Research Station, Hagari, Ballari which is situated in the Northern Dry Zone (Zone-3) of agro-climatic zones of Karnataka. The soil was medium black clayey in texture, low in organic carbon (0.48%), low in available nitrogen (191.0 kg N ha^{-1}), medium in available phosphorus (34.30 kg P_2O_5 ha^{-1}) and high in available potassium (480.0 kg K_2O ha^{-1}) with pH of 8.2. Sunflower hybrid RSFH-130, with duration of 100 days was used in the trial. The experiment was laid out in split plot design with three replications with a gross plot size of 21.60 m^2 and grown with common cultivation practices. The experiment consisted of four main plot treatments *viz.,* M_1; application of RDF (90:90:60 kg N, P_2O_5, K_2O /ha), M_2; application of RDF + FYM @ 8 t/ha, M_3; application of 85 % RDF + FYM @ 8 t/ha and M_4; application of 60 % RDF + FYM @ 8 t/ha and four sub plot treatments *viz.,* S_1; Control, S_2; foliar application of 19:19:19 water soluble foliar grade fertilizer @ 2% at 25 and 40 DAS, S_3; foliar application of 17:44 water soluble foliar grade fertilizer @ 2% at 25 and 40 DAS and S_4; foliar application of urea @ 2% at 25 and 40 DAS. The pretreated seeds with Imidacloprid and Ridomyl MZ were dibbled at a spacing of 60 x 30 cm. The fertilizer nitrogen, phosphorus and potassium were applied in the form of urea, di-ammonium phosphate and muriate of potash, respectively. Seventy five per cent of nitrogen and entire quantity of phosphorus and potassium fertilizers were applied as per the treatments at

the time of sowing. Top dressing (in band placement) of remaining twenty five per cent of nitrogen in the form of urea was applied at 40 days after sowing (DAS). The experimental plots were kept weed free by integrated weed management practices involving pre-emergence herbicide application of Pendimethalin 30 EC @ 4.5 l $ha^{-1}$with two inter cultivations (25 and 40 DAS) and one hand weeding at 40 DAS. The crop was kept disease and insect free by appropriate plant protection measures. Periodic observations on growth attributes were recorded at 25, 50, 75 DAS, at harvest and yield attributes were recorded at harvest. Oil content was estimated through Nuclear Magnetic Resonance (NMR) spectrometer against standard reference sample. Data collected at different stages were subjected to statistical analysis as described by Gomez and Gomez (1984). Treatment means were compared using Duncan's Multiple Range Test (DMRT).

Results and Discussion

Effect of different nutrient management practices on growth and yield attributes of sunflower

It is evident from the various nutrient management studies that crop yield strongly depends on the supply of nutrients and among the fertilizer nutrients, nitrogen (N) is critical, as it is a component of proteins, enzymes, nucleic acids and chlorophyll. Increased application rates of nitrogen leads to rapid leaf area development, prolongs life of foliage, increases leaf area duration after flowering and enhances crop assimilation consequently contributing to higher yield. Sunflower is an important fast growing and high yielding oilseed crop which removes considerable amount of nutrients to the extent of 63.3 kg N, 19.1 kg P_2O_5 and 126.0 kg K_2O to produce one ton (Hegde and Sudhakarababu, 2009). Nitrogen requirement for sunflower crop is high and that must be supplied throughout its growth and any shortage prior to flowering results in reduced head diameter, number of seeds $head^{-1}$, seed and oil yield. Phosphorus is the next major nutrient after nitrogen in limiting the sunflower production as phosphorus is more prone for fixation rendering it as unavailable to plants due to many soil reactions and interactions with other elements. Phosphorus is vital for plant growth and involved in energy transfer, photosynthesis, transformation of sugars, starches and nutrient movement within the plant. Adequate phosphorus supply results in better root penetration and proliferation contributing to production of photosynthates and their translocation to sink. When phosphorus is limiting the most striking effects is reduction in leaf expansion, leaf surface area and number of leaves (Hemalatha *et al.,* 2013).

Experimental results revealed that among the main plot treatments (nutrient management through soil application) application of RDF (90:90:60 kg N, P_2O_5, K_2O ha^{-1}) + FYM @ 8 t ha^{-1} recorded significantly higher plant height (173.89 cm), stem girth (6.68 cm), leaf area (64.59 dm^2/plant), leaf area duration (81.72 days), total dry matter production/plant (127.57 g/plant), head diameter (15.77 cm), seed yield/plant (43.40 g) and thousand seed weight (57.85 g) when compared to application of 60 per cent RDF + FYM @ 8 t ha^{-1+} and application of RDF alone. Among the sub plot treatments (nutrient management through foliar application of water soluble fertilizers) foliar application of 19:19:19 N, P_2O_5, K_2O fertilizer @ 2 % at 25 and 40 DAS produced higher plant height (168.60 cm), stem girth (6.46 cm), leaf area (60.69 dm^2/plant), leaf area duration (77.02 days), total dry matter production/plant (119.16 g/plant), head diameter (15.18 cm), seed yield/plant (40.29 g) and thousand seed weight (55.51 g) when compared to control and foliar

application of urea @ 2 % at 25 and 40 DAS (Table 1-4). Interaction of nutrient management through soil and foliar application indicated that application of RDF (90:90:60 kg N, P_2O_5, K_2O ha^{-1}) + FYM @ 8 t ha^{-1} with foliar application of 19:19:19 N, P_2O_5, K_2O fertilizer @ 2 % at 25 and 40 DAS produced higher plant height (181.50 cm), stem girth (7.57 cm), leaf area (70.97,dm^2/plant), higher leaf area duration (88.96 days), total dry matter production (136.97 g/plant), head diameter (16.50 cm), seed yield/plant (48.10 g) and thousand seed weight (63.80 g) when compared to other treatment combinations. However it remained on par with application of 85 per cent RDF + FYM @ 8 t ha^{-1} along with application of 19:19:19 water soluble foliar grade N, P_2O_5, K_2O fertilizer and 17:44 water soluble N, P_2O_5, fertilizer treatment.

Improvement in yield attributing parameters could be attributed to better growth parameters in addition to total dry matter production at different stages of the crop growth and it's partitioning into different parts and also might be due to higher NPK levels supplied along with FYM and additional amount of nitrogen, phosphorus, potassium supplied through the foliar application at 25 DAS and 40 DAS. Increased rates of nitrogen and phosphorus application leads to more rapid leaf area development, higher number of leaves, prolongs life of foliage, increases leaf area duration after flowering and enhances crop assimilation consequently contributing to higher yield.

These results are in conformity with the findings of Iqbal *et al.,* (2008), Khaliq *et al.,* (2008), Khaliq *et al.,* (2009), Ramulu *et al.,* (2011), Hemalatha *et al.,* (2013), Banerjee *et al.,* (2014), Jebarathnam and Sumalatha (2014), Gebremedhin *et al.,* 2015 where they observed larger head size, higher seed yield/ plant, 1000 seed weight, higher total dry matter production, higher number of seeds/head with application of RDF along with organics and foliar application of nutrients in addition to soil application.

Effect of different nutrient management practices on seed yield, oil content and oil yield of sunflower

Results of the experiment indicated that among the main plot treatments (nutrient management through soil application) application of RDF (90:90:60 kg N, P_2O_5, K_2O ha^{-1}) + FYM @ 8 t ha^{-1} recorded significantly higher seed yield (2403 kg/ha), stalk yield (4530 kg/ha), oil content (40.57 %) and oil yield (979 kg/ha) when compared to application of 60 per cent RDF + FYM @ 8 t ha^{-1+} and application of RDF alone. Among the sub plot treatments (nutrient management through water soluble foliar grade fertilizers) foliar application of 19:19:19 N, P_2O_5, K_2O fertilizer @ 2 % at 25 and 40 DAS produced higher seed yield (2233 kg/ha), stalk yield (4355 kg/ha), oil content (40.18 %) and oil yield (905 kg/ha) when compared to control and foliar application of urea @ 2 % at 25 and 40 DAS (Table 5-6). Interaction revealed that application of RDF (90:90:60 kg N, P_2O_5, K_2O ha^{-1}) + FYM @ 8 t ha^{-1} with foliar application of 19:19:19 N, P_2O_5, K_2O fertilizer @ 2 % at 25 and 40 DAS recorded significantly higher seed yield (2657 kg ha^{-1}), stalk yield (4687 kg/ha), oil content (43.07 %) and oil yield (1144 kg/ha) when compared to other treatment combinations and remained on par with application of FYM @ 8 t ha^{-1} with 85 per cent RDF along with application of 19:19:19 water soluble foliar grade N, P_2O_5, K_2O fertilizer and 17:44 water soluble N, P_2O_5 fertilizer treatment combinations. Increased seed yield, oil content and oil yield of sunflower could be directly attributed to response of crop to application of higher level of nutrients through soil and foliar application resulting in better morphological, growth and yield attributing characters.

Table.1 Plant height and stem girth of sunflower at harvest as influenced by nutrient management practices through soil application and water soluble foliar fertilizers

Nutrient management through soil application (NMPS)		Nutrient management through water soluble foliar fertilizers (WSFF)									
		Plant height (cm) at harvest					Stem girth (cm) at harvest				
		$WSFF_0$	**$WSFF_1$**	**$WSFF_2$**	**$WSFF_3$**	**Mean**	**$WSFF_0$**	**$WSFF_1$**	**$WSFF_2$**	**$WSFF_3$**	Mean
$NMPS_1$	Application of recommended dose of fertilizer (90 kg N, 90 kg P_2O_5 and 60 kg K_2O/ha)	139.90 hi	165.57 b-f	163.00 c-f	159.70 d-g	**157.04 b**	4.87 fg	5.93 bc	5.77 b-d	5.30 d-f	5.47 b
$NMPS_2$	Application of recommended dose of farmyard manure (8.0 t/ha) and recommended dose of fertilizers (90 kg N, 90 kg P_2O_5 and 60 kg K_2O/ha)	161.53 c-f	181.50 a	178.40 ab	174.13 a-d	**173.89 a**	5.47 c-e	7.57 a	7.47 a	6.20 b	6.68 a
$NMPS_3$	Application of recommended dose of farmyard manure (8.0 t/ha) and 85 % of recommended dose of fertilizers (76.5 kg N, 76.5 kg P_2O_5 and 51 kg K_2O/ha)	159.00 e-g	176.03 a-c	171.93 a-e	166.17 b-e	**168.28 ab**	5.10 e-g	7.27 a	7.13 a	5.87 bc	6.34 a
$NMPS_4$	Application of recommended dose of farmyard manure (8.0 t/ha) and 60 % of recommended dose of fertilizers (54 kg N, 54 kg P_2O_5 and 36 kg K_2O/ha)	135.13 i	151.30 f-h	146.90 g-i	142.73 hi	**144.02 c**	4.57 g	5.07 e-g	4.90 fg	4.67 g	4.80 c
Mean		**148.89 c**	**168.60 a**	**165.06 ab**	**160.68 b**		**5.00 c**	**6.46 a**	**6.32 a**	**5.51 b**	
Comparing the means of		**S.Em. ±**					S.Em. ±				
Nutrient management through soil application (NMPS)		3.46					0.12				
Nutrient management through water soluble foliar fertilizers (WSFF)		2.22					0.08				
WSFF at same NMPS		4.43					0.16				
NMPS at same or different WSFF		5.16					0.19				

$WSFF_0$ – Control (No foliar application of water soluble foliar fertilizer)	$WSFF_1$ – Foliar application of water soluble foliar 19:19:19 fertilizer (19 % N, 19 % P_2O_5 and 19 % K_2O) @ 2 % at 25 and 40 days after sowing
$WSFF_2$ – Foliar application of water soluble foliar 17:44 fertilizer (17 % N and 44 % P_2O_5) @ 2 % at 25 and 40 days after sowing	$WSFF_3$ – Foliar application of urea fertilizer (46 % N) @ 2 % at 25 and 40 days after sowing
DAS – Days after sowing	NS – Non-significant
Note : In a column mean values followed by the common letter are not significantly different at P = 0.05 (DMRT at 5 % level)	

Table.2 Leaf area per plant at 50 DAS and leaf area duration at 50-75 DAS of sunflower as influenced by nutrient management practices through soil application and water soluble foliar fertilizers

Nutrient management through soil application (NMPS)		Nutrient management through water soluble foliar fertilizers (WSFF)									
		Leaf area per plant (dm^2) at 50 DAS					Leaf area duration (days) at 50 - 75 DAS				
		$WSFF_0$	**$WSFF_1$**	**$WSFF_2$**	**$WSFF_3$**	**Mean**	**$WSFF_0$**	**$WSFF_1$**	**$WSFF_2$**	**$WSFF_3$**	Mean
$NMPS_1$	Application of recommended dose of fertilizer (90 kg N, 90 kg P_2O_5 and 60 kg K_2O/ha)	43.77 de	53.40 c	51.63 c	49.67 cd	**49.62 b**	58.96 gh	69.62 d	67.17 de	65.04 d-f	65.20 b
$NMPS_2$	Application of recommended dose of farmyard manure (8.0 t/ha) and recommended dose of fertilizers (90 kg N, 90 kg P_2O_5 and 60 kg K_2O/ha)	53.63 c	70.97 a	68.53 ab	65.23 ab	**64.59 a**	70.08 d	88.96 a	85.92 ab	81.92 bc	81.72 a
$NMPS_3$	Application of recommended dose of farmyard manure (8.0 t/ha) and 85 % of recommended dose of fertilizers (76.5 kg N, 76.5 kg P_2O_5 and 51 kg K_2O/ha)	52.77 c	69.20 a	66.20 ab	62.73 b	**62.73 a**	68.21 de	86.62 ab	83.37 bc	78.25 c	79.11 a
$NMPS_4$	Application of recommended dose of farmyard manure (8.0 t/ha) and 60 % of recommended dose of fertilizers (54 kg N, 54 kg P_2O_5 and 36 kg K_2O/ha)	41.17 e	49.20 cd	47.67 cd	45.33 de	**45.84 c**	54.00 h	62.87 e-g	60.50 fg	57.92 gh	58.82 c
Mean		**47.83 c**	**60.69 a**	**58.51 ab**	**55.74 b**		**62.81d**	**77.02a**	**74.24b**	**70.78c**	
Comparing the means of		**S.Em. ±**					S.Em. ±				
Nutrient management through soil application (NMPS)		0.81					1.39				
Nutrient management through water soluble foliar fertilizers (WSFF)		0.96					0.85				
WSFF at same NMPS		1.91					1.70				
NMPS at same or different WSFF		1.89					2.03				

$WSFF_0$ – Control (No foliar application of water soluble foliar fertilizer)	$WSFF_1$ – Foliar application of water soluble foliar 19:19:19 fertilizer (19 % N, 19 % P_2O_5 and 19 % K_2O) @ 2 % at 25 and 40 days after sowing
$WSFF_2$ – Foliar application of water soluble foliar 17:44 fertilizer (17 % N and 44 % P_2O_5) @ 2 % at 25 and 40 days after sowing	$WSFF_3$ – Foliar application of urea fertilizer (46 % N) @ 2 % at 25 and 40 days after sowing
DAS – Days after sowing	NS – Non-significant
Note : In a column mean values followed by the common letter are not significantly different at P = 0.05 (DMRT at 5 % level)	

Table.3 Total dry matter production and head diameter of sunflower at harvest as influenced by nutrient management practices through soil application and water soluble foliar fertilizers

Nutrient management through soil application (NMPS)		Nutrient management through water soluble foliar fertilizers (WSFF)									
		Total dry matter production (g/plant) at harvest					Head Diameter (cm) at harvest				
		$WSFF_0$	**$WSFF_1$**	**$WSFF_2$**	**$WSFF_3$**	**Mean**	**$WSFF_0$**	**$WSFF_1$**	**$WSFF_2$**	**$WSFF_3$**	Mean
$NMPS_1$	Application of recommended dose of fertilizer (90 kg N, 90 kg P_2O_5 and 60 kg K_2O/ha)	90.30gh	112.77de	107.30 e	103.43ef	**103.45c**	12.40g-i	14.90b-e	14.53c-f	13.63e-g	13.87 b
$NMPS_2$	Application of recommended dose of farmyard manure (8.0 t/ha) and recommended dose of fertilizers (90 kg N, 90 kg P_2O_5 and 60 kg K_2O/ha)	113.20de	136.97 a	132.83ab	127.27a-c	**127.57a**	14.60c-f	16.50a	16.40a	15.57a-d	15.77 a
$NMPS_3$	Application of recommended dose of farmyard manure (8.0 t/ha) and 85 % of recommended dose of fertilizers (76.5 kg N, 76.5 kg P_2O_5 and 51 kg K_2O/ha)	108.30 e	129.90ab	125.03bc	119.27cd	**120.63b**	14.30d-f	16.10ab	15.90a-c	15.20a-d	15.38 a
$NMPS_4$	Application of recommended dose of farmyard manure (8.0 t/ha) and 60 % of recommended dose of fertilizers (54 kg N, 54 kg P_2O_5 and 36 kg K_2O/ha)	85.30 h	97.00 fg	93.17 gh	90.70 gh	**91.54 d**	11.23i	13.23f-h	12.70gh	12.03hi	12.30 c
Mean		**99.28 c**	**119.16a**	**114.58ab**	**110.17 b**		**13.13c**	**15.18a**	**14.88a**	**14.11b**	
Comparing the means of		**S.Em. ±**					S.Em. ±				
Nutrient management through soil application (NMPS)		1.34					0.38				
Nutrient management through water soluble foliar fertilizers (WSFF)		1.60					0.23				
WSFF at same NMPS		3.20					0.46				
NMPS at same or different WSFF		3.08					0.55				

$WSFF_0$ – Control (No foliar application of water soluble foliar fertilizer)	$WSFF_1$ – Foliar application of water soluble foliar 19:19:19 fertilizer (19 % N, 19 % P_2O_5 and 19 % K_2O) @ 2 % at 25 and 40 days after sowing
$WSFF_2$ – Foliar application of water soluble foliar 17:44 fertilizer (17 % N and 44 % P_2O_5) @ 2 % at 25 and 40 days after sowing	$WSFF_3$ – Foliar application of urea fertilizer (46 % N) @ 2 % at 25 and 40 days after sowing
DAS – Days after sowing	NS – Non-significant
Note : In a column mean values followed by the common letter are not significantly different at P = 0.05 (DMRT at 5 % level)	

Table.4 Seed yield per plant and 1000 seed weight of sunflower as influenced by nutrient management practices through soil application and water soluble foliar fertilizers

Nutrient management through soil application (NMPS)		Nutrient management through water soluble foliar fertilizers (WSFF)									
		Seed yield per plant (g)					1000 seed weight (g)				
		$WSFF_0$	**$WSFF_1$**	**$WSFF_2$**	**$WSFF_3$**	**Mean**	**$WSFF_0$**	**$WSFF_1$**	**$WSFF_2$**	**$WSFF_3$**	Mean
$NMPS_1$	Application of recommended dose of fertilizer (90 kg N, 90 kg P_2O_5 and 60 kg K_2O/ha)	27.33 e-g	36.97 b-d	36.23b-e	33.60c-f	**33.53b**	42.63e	54.57bc	51.20c	49.70cd	49.53b
$NMPS_2$	Application of recommended dose of farmyard manure (8.0 t/ha) and recommended dose of fertilizers (90 kg N, 90 kg P_2O_5 and 60 kg K_2O/ha)	37.23 b-d	48.10 a	47.37 a	40.88 a-c	**43.40 a**	51.10c	63.80a	62.37a	54.13bc	57.85a
$NMPS_3$	Application of recommended dose of farmyard manure (8.0 t/ha) and 85 % of recommended dose of fertilizers (76.5 kg N, 76.5 kg P_2O_5 and 51 kg K_2O/ha)	33.77c-f	44.90 ab	43.97 ab	37.20 b-d	**39.96 a**	49.87cd	60.20ab	59.57ab	55.23bc	56.22a
$NMPS_4$	Application of recommended dose of farmyard manure (8.0 t/ha) and 60 % of recommended dose of fertilizers (54 kg N, 54 kg P_2O_5 and 36 kg K_2O/ha)	22.00 g	31.20 d-f	30.03 d-g	26.63 fg	**27.47 c**	39.60e	43.47de	42.87e	40.33e	41.57c
Mean		**30.08c**	**40.29a**	**39.40a**	**34.58b**		**45.80c**	**55.51a**	**54.00a**	**49.85b**	
Comparing the means of		**S.Em. ±**					S.Em. ±				
Nutrient management through soil application (NMPS)		1.24					1.57				
Nutrient management through water soluble foliar fertilizers (WSFF)		1.41					1.09				
WSFF at same NMPS		2.81					2.18				
NMPS at same or different WSFF		2.73					2.45				

$WSFF_0$ – Control (No foliar application of water soluble foliar fertilizer)	$WSFF_1$ – Foliar application of water soluble foliar 19:19:19 fertilizer (19 % N, 19 % P_2O_5 and 19 % K_2O) @ 2 % at 25 and 40 days after sowing
$WSFF_2$ – Foliar application of water soluble foliar 17:44 fertilizer (17 % N and 44 % P_2O_5) @ 2 % at 25 and 40 days after sowing	$WSFF_3$ – Foliar application of urea fertilizer (46 % N) @ 2 % at 25 and 40 days after sowing
DAS – Days after sowing	NS – Non-significant
Note : In a column mean values followed by the common letter are not significantly different at P = 0.05 (DMRT at 5 % level)	

Table.5 Seed yield and stalk yield of sunflower as influenced by nutrient management practices through soil application and water soluble foliar fertilizers

Nutrient management through soil application (NMPS)		Nutrient management through water soluble foliar fertilizers (WSFF)									
		Seed yield (kg/ha)					Stalk yield (kg/ha)				
		$WSFF_0$	**$WSFF_1$**	**$WSFF_2$**	**$WSFF_3$**	**Mean**	**$WSFF_0$**	**$WSFF_1$**	**$WSFF_2$**	**$WSFF_3$**	Mean
$NMPS_1$	Application of recommended dose of fertilizer (90 kg N, 90 kg P_2O_5 and 60 kg K_2O/ha)	1794e-g	2025c-e	1921d-f	1863d-f	**1901b**	3848d-g	4310a-e	4270a-e	4040b-f	4117b
$NMPS_2$	Application of recommended dose of farmyard manure (8.0 t/ha) and recommended dose of fertilizers (90 kg N, 90 kg P_2O_5 and 60 kg K_2O/ha)	2060c-e	2657a	2567ab	2326a-c	**2403a**	4293a-e	4687a	4620 ab	4520 ab	4530a
$NMPS_3$	Application of recommended dose of farmyard manure (8.0 t/ha) and 85 % of recommended dose of fertilizers (76.5 kg N, 76.5 kg P_2O_5 and 51 kg K_2O/ha)	1905d-f	2581ab	2403a-c	2222b-d	**2278a**	4260a-e	4553ab	4497a-c	4450 a-d	4440a
$NMPS_4$	Application of recommended dose of farmyard manure (8.0 t/ha) and 60 % of recommended dose of fertilizers (54 kg N, 54 kg P_2O_5 and 36 kg K_2O/ha)	1454g	1667e-g	1597fg	1551fg	**1567c**	3567f	3870c-f	3720ef	3707ef	3716c
Mean		**1803c**	**2233a**	**2122ab**	**1991b**		**3992b**	**4355a**	**4277ab**	**4179ab**	
Comparing the means of		**S.Em. ±**					S.Em. ±				
Nutrient management through soil application (NMPS)		66					56				
Nutrient management through water soluble foliar fertilizers (WSFF)		61					95				
WSFF at same NMPS		121					189				
NMPS at same or different WSFF		123					175				

$WSFF_0$ – Control (No foliar application of water soluble foliar fertilizer)	$WSFF_1$ – Foliar application of water soluble foliar 19:19:19 fertilizer (19 % N, 19 % P_2O_5 and 19 % K_2O) @ 2 % at 25 and 40 days after sowing
$WSFF_2$ – Foliar application of water soluble foliar 17:44 fertilizer (17 % N and 44 % P_2O_5) @ 2 % at 25 and 40 days after sowing	$WSFF_3$ – Foliar application of urea fertilizer (46 % N) @ 2 % at 25 and 40 days after sowing
DAS – Days after sowing	NS – Non-significant
Note : In a column mean values followed by the common letter are not significantly different at P = 0.05 (DMRT at 5 % level)	

Table.6 Seed oil content and oil yield of sunflower as influenced by nutrient management practices through soil application and water soluble foliar fertilizers

Nutrient management through soil application (NMPS)		Nutrient management through water soluble foliar fertilizers (WSFF)									
		Seed oil content (%)					Oil yield (kg/ha)				
		$WSFF_0$	**$WSFF_1$**	**$WSFF_2$**	**$WSFF_3$**	**Mean**	**$WSFF_0$**	**$WSFF_1$**	**$WSFF_2$**	**$WSFF_3$**	Mean
$NMPS_1$	Application of recommended dose of fertilizer (90 kg N, 90 kg P_2O_5 and 60 kg K_2O/ha)	35.17 ef	38.77 a-f	37.83 b-f	36.50 c-f	**37.07 b**	628 f-h	788 d-f	721 e-g	682 e-g	705 b
$NMPS_2$	Application of recommended dose of farmyard manure (8.0 t/ha) and recommended dose of fertilizers (90 kg N, 90 kg P_2O_5 and 60 kg K_2O/ha)	38.03 b-f	43.07 a	42.07 ab	39.10 a-e	**40.57 a**	780 d-f	1144 a	1079 ab	913 b-d	979 a
$NMPS_3$	Application of recommended dose of farmyard manure (8.0 t/ha) and 85 % of recommended dose of fertilizers (76.5 kg N, 76.5 kg P_2O_5 and 51 kg K_2O/ha)	37.40 b-f	41.07 a-c	40.47 a-d	38.47 b-f	**39.35 a**	708 e-g	1057 ab	971 a-c	860 c-e	899 a
$NMPS_4$	Application of recommended dose of farmyard manure (8.0 t/ha) and 60 % of recommended dose of fertilizers (54 kg N, 54 kg P_2O_5 and 36 kg K_2O/ha)	34.23 f	37.80 b-f	36.20 d-f	35.77 d-f	**36.00 b**	495 h	632 f-h	583 gh	558 gh	567 c
Mean		**36.21c**	**40.18a**	**39.14ab**	**37.46bc**		**653c**	**905a**	**838a**	**753b**	
Comparing the means of		**S.Em. ±**					S.Em. ±				
Nutrient management through soil application (NMPS)		0.46					29				
Nutrient management through water soluble foliar fertilizers (WSFF)		0.69					28				
WSFF at same NMPS		1.38					55				
NMPS at same or different WSFF		1.28					56				

$WSFF_0$ – Control (No foliar application of water soluble foliar fertilizer)	$WSFF_1$ – Foliar application of water soluble foliar 19:19:19 fertilizer (19 % N, 19 % P_2O_5 and 19 % K_2O) @ 2 % at 25 and 40 days after sowing
$WSFF_2$ – Foliar application of water soluble foliar 17:44 fertilizer (17 % N and 44 % P_2O_5) @ 2 % at 25 and 40 days after sowing	$WSFF_3$ – Foliar application of urea fertilizer (46 % N) @ 2 % at 25 and 40 days after sowing
DAS – Days after sowing	NS – Non-significant
Note : In a column mean values followed by the common letter are not significantly different at P = 0.05 (DMRT at 5 % level)	

These results are in accordance with the findings of Sagare *et al.*, (1986), Reddy *et al.*, (1992), Veerabhadrappa, (2003), Chandrashekaran (2004), Haseeb and Maqbool (2015) who opined that in addition to soil applied fertilizers foliar spray of nutrients resulted in higher seed yield in sunflower and groundnut.

References

Anonymous, 2016, State of Indian Agriculture 2016, Directorate of Economics and Statistics, Ministry of Agriculture and Farmers welfare, Department of Agriculture, Co-operation and Farmers Welfare, GOI. pp. 119.

Banerjee, H., Dutta, S. K., Pramanik, S. J., Ray, K., Phonglosa, A. and Bhattacharyya, K., 2014, Productivity and profitability of spring planted sunflower hybrid with nitrogen, phosphorus and potassium fertilizer. *Annals Pl. Soil Res.*, 16(3): 250-256.

Biradar, D. P., Aladakatti, Y. R. and Basavanneppa, M. A., 2012, Enhancing the productivity and economic returns of field crops with balanced nutrient application through site specific nutrient management approach. Proc. 3rd National Conference on Agro-informatics and Precision Agriculture 2012 (AIPA, 2012) 1-3 August 2012, Hyderabad India. p. $146^{-1}51$.

Chandrashekaran, 2004, Effect of foliar application of DAP and $ZnSO_4$ on growth and productivity of groundnut. *Int. J. Agric. Sci*., 4(2): 548-550.

Gebremedhin, T., Shanwad, U. K., Gebremedhin, W. and Rama, A., 2015, Efficacy of foliar nutrition on vegetative and reproductive growth of sunflower (*Helianthus annuus* L.) *Global J. Sci. Frontier Res. Agric. Vet.*, 15(9): 37-41.

Gomez, K. A. and Gomez, A. A., 1984, *Statistical Procedures for Agricultural Research*, 2nd Edition, A Wiley-International Science Publ., New York (USA), pp. 125-130.

Haseeb, M. and Maqbool, N., 2015, Influence of foliar applied nitrogen on reproductive growth of sunflower (*Helianthus annuus* L.) under water stress. *Agric. Sci*., 6:1413-1420.

Hegde, D. M. and Sudhakarababu, S. N., 2009, Declining factor productivity and improving nutrient-use efficiency in oilseeds. *Indian J. Agron.*, 54(1): 1-8.

Hemalatha, S., Praveen, R., Padmaja, J. and Suresh, K., 2013, An over view on role of phosphorus on growth, yield and quality of sunflower. *Int. J. Applied Biol. Pharm. Technol.*, 4(3): 48-55.

Iqbal, J., Hussain, B., Saleem, M. F., Munir, M. A. and Aslam, M., 2008, Bio-economics of autumn planted sunflower (*Helianthus annuus* L.) hybrids under different NPK applications. *Pakistan J. Agric. Sci*., 45(3): 19-24.

Jebarathnam, G. T. and Sumalatha, 2014, Integrated nutrient management in sunflower and apiary farming system. *Int. Res. J. Chem.*, 7: 01-11.

Khaliq, T. A., Ahmad, A. Hussain and Ali, M. A., 2008, Impact of nitrogen rate on growth, yield and radiation use efficiency of maize under varying environments. *Pakistan J. Agri. Sci.*, 45: 1-7.

Khaliq, T., Ahmad, A., Hussain, A. and Ali, M. A., 2009, Maize hybrids response to nitrogen rates at multiple locations in semi arid environment. *Pakistan J. Bot.*, 41: 207-224.

Ramulu, N., Krishnamurthy, H. M., Jayadeva, M., Janardhan, C. and Ramachandra, C., 2011, Influence of different levels of nutrient on growth and yield on sunflower under irrigated conditions of eastern dry zone of Karnataka, India. *Plant Archives*, 11(2): 1025-1028.

Reddy, S. Y., Husain, M. M., Kasturi, K., Reddy, B. B. and Reddy, G. V., 1992, Effect of soil and foliar application of nitrogen in sunflower under rainfed conditions. *Indian J. Agron.,* 37(4): 863-865.

Sagare, B. N., Naphade, K. T. and Joshi, B. G., 1986, Effect of urea and DAP sprays on yield and nutrient uptake by sunflower. *J. Maharashtra Agric. Univ.,* 11: 54-56.

Veerabhadrappa, B. H., 2003, Effect of foliar nutrition (N, P, K, Ca and S) on growth and yield of groundnut grown in alfisols. *J. Oilseeds Res*., 9(2): 2003.

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