Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.5, No.15, 2015

Soil test Based Nutrient Management for Sunflower (*Helianthus annuus* L.): Analysis of Growth, Biomass, Nutrient uptake and soil nutrient status

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Abstract
The Studies were carried out to assess the influence of different levels of soil test based nutrient management on Growth, Biomass, Nutrient uptake and Available soil nutrient status of sunflower. The results revealed that the maximum taller plants, more number of leaves, leaf area dm^2, leaf area index, nutrient uptake kg ha^{-1}, available nutrients kg ha^{-1} and total Biomass production (108.07 g $plant^{-1}$) was obtained with T_9 (STCR approach + Foliar spray of NPK @ 1% + $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% and B @ 0.2%), which was, at par with treatments where T_3 (STCR approach) and T_8 (Soil test based NPK + Foliar spray of NPK @ 1% + $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% and B @ 0.2%)was applied. While the minimum Biomass production (86.89 g $plant^{-1}$) and growth characteristics were recorded in case of foliar spray of T_4 (NPK @ 1% + $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% and B @ 0.2%). Nutrient management based on soil tested data besides maintaining the available N, P and K of soil, leading to positive nutrient balance.
Keywords: Biomass production, soil testing, nutrient uptake, Available nutrient, Sunflower

Introduction

The goal of nutrient management is to maximize plant productivity while minimizing environmental consequences. Nutrient management plans document available nutrient sources, production practices, and other management practices that influence nutrient availability, crop productivity and environmental stewardship. For over 40 years, soil testing has been a recommended means of predicting the kind and amount of fertilizers needed. Yet many farmers still do not use this relatively simple tool to increase fertilizers profitability. Producers still apply fertilizer where no one is required or at lower rates than required or at higher rates than required to optimize yields. Others apply inadequate rates or use ineffective application methods. While soil test recommendations for nutrient requirements and optimum rates needed for maximum profit are not always totally correct, they are superior to no soil testing program at all.

The yield increase in paddy due to fertilizer application based on recommendation of soil test value ranged from 7.22 to 69 per cent compared to the farmer's usual practice (Subra money and Padmanabhan, 1969). Santhi and Selvakumari (1999) developed fertilizer adjustment equations and post harvest soil test values prediction equations for *kharif* and *rabi* seasons using the data on grain yield, total uptake, initial soil test values and fertilizer doses. From these equations fertilizer doses were given for desired yield targets of rice crops. Soil test-based nutrient management approach can be an important entry point activity and also a mechanism to diagnose and manage soil fertility in practical agriculture (Wani, 2008). Soil test-based nutrient application also allows judicious and efficient use of nutrient inputs at the local and regional levels (Sahrawat *et al*., 2010). Sharma and Singh (2005) reported existence of operational range of soil test values after fertility gradient experiment with preliminary crop pearl millet for development of soil test based fertilizer recommendation to obtain economic yield of wheat crop. The objective of the carried out study is to demonstrate the effect of soil test based fertilization on the soil nutrient status and different growth parameter of the sunflower so that farmers of the region got benefitted by judicious use of the fertilizers after testing their soil.

Material and Method

Field experiment was conducted during 2013 growing seasons at the University of Agricultural Sciences, Raichur in the North Eastern Dry Zone of Karnataka, India to findout the influence of different soil test based nutrient management on yield characteristics and the soil nutrient status in sunflower producing area. Nine nutrient management practices *viz.,* T_1 - Recommended NPK as per POP (90:90:60 N P K kg ha^{-1}) , T_2 - Soil test based NPK (STL method) , T_3 - STCR approach (Yield target: 25 q/ha) , T_4 - Foliar spray of nutrients NPK (19:19:19 @ 1% spray at 15, 30, 45 and 60 DAS) + Zn (0.5%) and Fe (0.5%) sprays at 30, 45 and 60 DAS + B (0.2%) sprays at 50% flowering , T_5 - T_1 + T_4 , T_6 - 75% Recommended NPK + T_4 , T_7 - 50% Recommended NPK + T_4 , T_8 (T_2 + T_4) , T_9 (T_3 + T_4) were assigned to plot. According to results of soil analysis 102.5:90:60 N: P2O5:K2O kg ha^{-1}, 96:165:57: N, P2O5, K2O kg ha^{-1} and for RDF 90:90:60 kg ha^{-1} Basal dose of fertilizer

for T_2, T_3 and T_1 respectively was used.

The soil of the experimental field was of clay loam type. The available nutrient status of the field was low in nitrogen (234 kg ha^{-1}), medium in phosphorus (39.78 kg ha^{-1}) and potassium (405.02 kg ha^{-1}). The organic carbon content was 0.62 % with pH 7.96. The sunflower variety RSFH-130 was used for this experiment with a seed rate of 15 kg ha^{-1} and spacing of 60 cm between rows and 30 cm between plants the crop was not received any supplemental irrigation during the crop growth period.

Result and Discussions

Growth attributes and Total Biomass Production

Data on plant height, number of leaves per plant, leaf area, leaf area index and total biomass production described in Table 1 show that different soil test based fertilization showed that highly significant effect on different Growth attribute of the crop.

The higher plant height (191.70 cm), number of leaves per plant (22.17), leaf area (17.32 dm^2), leaf area index (0.96) and total Biomass production (108.07 g $plant^{-1}$) was recorded in T_9 treatment where (STCR approach + Foliar spray of NPK @ 1% + $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% and B @ 0.2%). This treatment differed significantly from rest of the treatments except T_3 and T_8 on plant height, number of leaves per plant; leaf area and leaf area index whereas the total biomass production was significantly differed only on T_3. The lowest Growth attributes was observed in case of T_4 Foliar spray of NPK @ 1% + $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% and B @ 0.2%). The nourishment of N, P and K along with foliar nutrition accomplished the requirement of balanced crop nutrition and caused rapid division and elongation of cells that resulted in improved plant height, leaf area and biomass production per plant. The results are in line with those of Elnaz *et al.* (2010) and Ramachandrappa and Najappa (2005). The significantly lower growth parameter was noticed on the treatment T_4 (solely foliar spray of NPK @ 1% + ZnSO4 @ 0.5% + FeSO4 @ 0.5% and B @ 0.2%) because providing only foliar nutrition might not have fulfilled the crop demand.

Table 1: Growth characteristics and total biomass production of sunflower as influenced by different Soil test based nutrient management

Treatments		Plant height (cm)	Number of leaves	Leaf area (dm^2)	Leaf area index	Total dry matter production (g plant-1)
T_1	RDF (control)	174.4	15.83	15.4	0.86	95.9
T_2	Soil test based NPK (STL method)	180.34	17.78	15.5	0.86	98.4
T_3	STCR approach (Yield target: 25 q/ha)	185	21.17	16.76	0.93	103.27
T_4	Foliar spray of NPK + $ZnSO_4$ + $FeSO_4$ and B	165	11.53	11.73	0.65	86.89
T_5	T_1 + T_4	174.67	16.41	15.43	0.86	97.07
T_6	75% RDF + T_4	171	15.74	15.11	0.84	94.63
T_7	50% RDF + T_4	167	14.96	14.58	0.81	91.73
T_8	T_2 + T_4	182.67	18.62	16.77	0.93	101.6
T_9	T_3 + T_4	191.7	22.17	17.32	0.96	108.07
	S.Em±	2.8	1.18	0.47	0.03	1.74
	C.D. at 5%	8.4	3.56	1.42	0.08	5.23

Nutrient uptake and soil nutrient status

Data in Table 2 exhibit that different levels of soil test fertilization had highly significant effect on the parameter under discussion.

The maximum nitrogen uptake (103.52 kg ha^{-1}), Phosphorous uptake (35.83 kg ha^{-1}) and potassium uptake (90.32 kg ha^{-1}) was recorded in T_9 where (STCR approach + Foliar spray of NPK @ 1% + $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% and B @ 0.2%) was used. This treatment was statistically on par with T_3 and T_8 treatments. The lowest level of N, P and K nutrient uptake was found in case of T_4 (68.67 kg ha^{-1}), (18.53 kg ha^{-1}) and (63.10 kg ha^{-1}), respectively.

The maximum available nutrient status of the Nitrogen (251.83 kg ha^{-1}), Phosphorous uptake (40.49 kg ha^{-1}) and potassium uptake (411.67 kg ha^{-1}) after harvest was recorded in T_9 where (STCR approach + Foliar spray of NPK @ 1% + $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% and B @ 0.2%) was used. This treatment was statistically on par with T_3 and T_8 treatments.

In general, the higher uptake and the availability of these nutrients were due to higher availability and high dry matter production. The results were in accordance with the findings of Yakadri and Satyanarayana

(1995). The increased nutrient application through SSNM approach resulted in greater absorption of nutrients from soil and these in turn led to higher NPK content in seed and stalk. The results are in line with the findings of Mishra et al. (1995) and Thavaprakash (2000). A significant and positive relation was observed between applied fertilizer levels of N, P and K and their available forms in the soil. Similar results were reported by Vandhana (2003).

Table 2: Nutrient uptake and available nutrient status of sunflower as influenced by different Soil test based nutrient management

Tr. No.	Treatments	Nutrient uptake (kg ha^{-1})			Available nutrient status of soil (kg ha^{-1})		
		Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus	Potassium
T_1	RDF (Control)	81.77	29	79.87	220.4	31.02	373.23
T_2	Soil test based NPK (STL method)	85.33	31.4	82.93	231.53	31.83	382.33
T_3	STCR approach (Yield target: 25 q/ha)	97	34.67	87.55	247.8	37.76	405.73
T_4	Foliar spray of NPK + $ZnSO_4$ + $FeSO_4$ and B	68.67	18.53	63.1	211.3	26.22	356.33
T_5	$T_1 + T_4$	82.63	30.87	81.53	222.24	33.33	374.67
T_6	75% RDF + T_4	77	20.8	75.3	218.7	28.57	365.27
T_7	50% RDF + T_4	74.33	19.4	67.37	215	28.36	361.33
T_8	$T_2 + T_4$	94.33	33.13	85.1	244.27	36	401
T_9	$T_3 + T_4$	103.52	35.83	90.32	251.83	40.49	411.67
	S.Em±	4.18	1.34	2.09	2.82	2.64	6.47
	C.D. at 5%	12.54	4.04	6.26	8.47	7.93	19.4

Conclusion

From the results of the study, it could be concluded that the soil test based nutrient of (96:165:57: N, P_2O_5, K_2O kg ha^{-1}) to basal application of fertilizer (half of nitrogen and full dose of phosphorus and potassium) at the time of sowing and remaining half of nitrogen recommended at 30 DAS along with foliar spray of NPK @ 1% + ZnSO4 @ 0.5% + FeSO4 @ 0.5% and B @ 0.2% was found superior in increasing the growth characteristics, total biomass production, total nutrient uptake and available nutrient status in soil. Thus, balanced nutrition concept focus on the use of plant nutrients in a definite proportion as required by the crops, which is possible only if one knows the available nutrient status of his soils.

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