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RESEARCH ARTICLE

Optimizing the fertilizer requirement for economic yields through response curve in sunflower genotypes

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ABSTRACT

A filed experiment was conducted at College of Agriculture Rajendranagar, Hyderbabad (AP) India to estimate the nutrient removal by leaves, stems, and seeds for the optimal fertilizer requirement to obtain economic yield and to estimate the response curve of nitrogen for two genotypes (Morden and KBSH-1) of sunflower with six levels of fertilizer application during the *Kharif* season in the year 2005-06. The results revealed that nitrogen removal by leaves of sunflower in case of genotype KBSH-1 was significantly higher than that of Morden in all the growth stages except at 75 days after sowing (DAS). The removal of nitrogen by sunflower leaves was not significantly influenced by different levels of fertilizer nutrients at 30 days after sowing. However, the application of 60 kg N ha^{-1} was the outstanding treatment to absorb adequate quantity of nutrients for the production of high seed yield. Further, the two genotypes removed relatively more N through the leaves than the stem in the vegetative phase at 30 DAS. Hence, the dry weight of leaves was more than the stem at this stage. The removal of N was slightly more in the stem than in the leaf during the bud stage of the crop. Maximum quantities of nutrients was absorbed by the stem during flowering stage. The study also revealed that, response curve indicated with incremental levels of nitrogen which showed that the seed yield of Morden can be maximized by an increase in nutrient upto 125 kg ha^{-1} and 126 kg ha^{-1} for KBSH-1.

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INTRODUCTION

Sunflower (*Helianthus annuus* L.) is an important oilseed crop in India popularly known as "Surajmukhi." The name "Helianthus" is derived from 'Helios' meaning 'sun' and 'anthos' meaning 'flower'. It is known as sunflower as it follows the sun by day, always turning towards its direct rays. It is one of the fastest growing oilseed crops in India and a major source of vegetable oil in the world. The applied nutrients are removed from the soil in large quantity due to harvest of the crops. Nitrogen is necessary for the synthesis of the proteins which are essential for the development of tissues. After flowering, most of the crops contain lesser percentage of nitrogen due to greater accumulation of carbohydrates and uptake of nitrogen is slow at the later stage which is generally met through soil mineralization. When the weather is favourable, response to the applied N is excellent and losses are low irrespective of the depth, but when periods of excessive rain occurs, loss of applied N increases, particularly in the shallow light soils. Judicious and efficient crop nutrition is possible only when the amounts and forms present in soil and the management practices are fine tuned to the crop plant needs (Prasad, 2007). With this back drop, the research study undertaken to estimate the response curve of nitrogen and the quantity of N removed in different stages of crop growth through leaves, stem and seeds and its optimal

requirement for obtaining economic yield levels in southern Telangan region of Andhra Pradesh.

MATERIAL AND METHODS

The field experiment was conducted during *Kharif* in the year 2005-06 at Agricultural College farm, Rajendranagar, Hyderabad, Andhra Pradesh situated at an altitude of 521.0 m above MSL on 17^{0}19'17.96 N latitude and 78^0 25'10.92" E longitude. The soil condition was sandy loam in texture with pH of 7.5, EC of 0.215 dS m^{-1} and organic carbon (0.4 %). The soil was low in available N (168.9 kg ha^{-1}), available P_2O_5 (23.0 kg ha^{-1}) and medium available K_2O (249.3 kg ha^{-1}). In study area, total rainfall was 484.8 mm, received in 26 rainy days from sowing to harvest. The experiment was carried out in Randomised Block Design with two sunflower genotypes (Morden and KBSH-1) and six levels of fertilizers in four replications. The nitrogen fertilizer was applied in three splits (1/2 as basal, 1/3rd at 30 DAS and at bud initiation stage).The data were subjected to 2×6 factorial analysis to draw the conclusion and response curve was estimated to know the optimal requirement of N kg ha^{-1}.

RESULTS AND DISCUSSION

The results obtained from the present investigation are summarized below :

Nitrogen removal by leaves :

The results of the study revealed that leaves of sunflower genotype KBSH-1 removed more nitrogen than Morden (Table 1). This effect was significant during all the stages except at 75 DAS. The removal of nitrogen by sunflower leaves was not significantly influenced by different levels of fertilizer nutrients at 30 DAS. Sunflower fertilized with 60 kg N ha^{-1} rendered the leaves to remove significantly more quantity of nitrogen compared to the unfertilized crop at 45 and 75 DAS. But the application of 90 kg N ha^{-1} induced the leaves to remove significantly more quantity of nitrogen compared to control at 60 DAS. The interactions were not significant. The two genotypes removed relatively more N through the leaves than the stem in the vegetative phase at 30 DAS (Fig.1). Hence, the dry weight of leaves was more than the stem at this stage. This relationship of nutrient removal and the dry weight of the plant also corroborated in the later stages of crop growth.

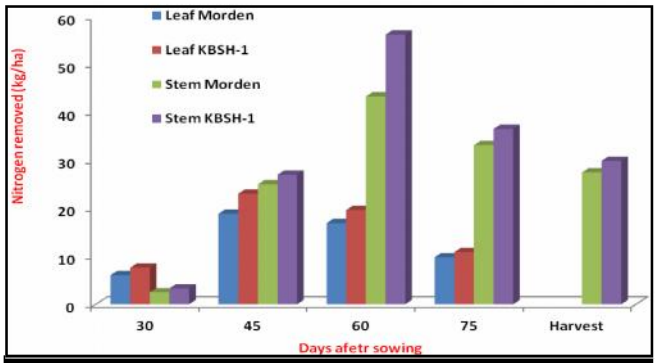

Fig. 1 : Nitrogen removed (kg ha^{-1}) in different plant parts of sunflower genotypes-Morden and KBSH-1 during different stages of crop growth.

Table 1 : Nitrogen removal (kg ha^{-1}) in different plant parts of sunflower genotypes as influenced by different levels of fertilizer

Treatments	Days after sowing									Seed
	Leaf				Stem					
	30	45	60	75	30	45	60	75	Harvest	
Genotype										
Morden	6.08	18.88	16.93	9.82	2.50	25.01	43.33	33.17	27.48	33.63
KBSH-1	7.63	23.05	19.65	10.86	3.32	27.01	56.22	36.56	29.90	37.05
SE±	0.45	1.49	1.32	0.84	0.20	1.51	2.42	1.87	1.66	2.16
CD (P=0.05)	0.91	3.04	2.69	NS	0.40	NS	4.94	NS	NS	NS
Fertilizer(N kg ha^{-1})										
0	5.71	13.65	6.75	6.09	1.75	13.71	20.32	14.10	11.13	18.39
30	6.10	15.89	13.66	7.16	2.43	19.90	34.59	25.42	21.71	26.94
60	6.44	22.58	18.46	11.48	3.08	25.48	51.06	38.62	32.02	36.80
90	7.18	22.28	23.53	11.58	3.34	31.36	59.13	43.33	34.90	41.42
120	7.43	23.72	22.84	13.07	3.29	32.44	63.05	43.55	34.42	43.95
150	8.28	27.65	24.48	12.66	3.58	33.18	70.52	44.18	37.96	44.55
SE±	0.78	2.59	2.29	1.45	0.34	2.61	4.20	3.24	2.88	3.75
CD (P=0.05)	NS	5.29	4.68	2.96	0.69	5.32	8.57	6.61	5.88	7.63
Interaction										
SE±	1.11	3.66	3.23	2.04	0.48	3.69	5.94	4.58	4.07	5.29
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS=Non-significant

Nitrogen removal by stem :

The two genotypes of sunflower *viz.*, Morden and KBSH-1 removed nitrogen on par with each other at different stages except at 30 and 60 DAS (Table 1). The genotype KBSH-1 removed significantly more quantity of nitrogen during these two sampling stages. Sunflower fertilized with 30 kg N ha^{-1} invariably removed significantly more nitrogen through its stem at every stage of sampling at 15 days interval from 30 DAS until harvest. The crop tended to remove more nitrogen with increase in the level of nutrients. The interactions were not significant to exert a remarkable variation in the response pattern of nitrogen removed by the two genotypes due to different levels of fertility. The removal of N was slightly more in the stem than in the leaf during the bud stage of the crop. Hence, the dry weight of the stem was slightly more than the leaves. Maximum quantities of nutrients were absorbed by the stem during flowering stage. This indicates that the nutrients were translocated to the stem very rapidly. This coincided with the grand growth of the crop with a remarkable increase in plant height and dry matter accumulation in the stem. The nutrient content in the leaves reduced sharply at 75 DAS which coincided with seed filling stage of the crop. This reduction could possibly be attributed to the senescence of lower leaves and the translocation of the nutrients from the young leaves to the capitulum through the stems. The N content in the stem was also low at seed filling than in the flowering stage. Obviously, this reduction also owe to their translocation to the sink.

Nitrogen removal by seed :

The seed of sunflower genotype Morden recovered 33.63 kg N ha^{-1}. This was on par with 37.05 kg N ha^{-1} removed by KBSH-1 (Table 1). Fertilizer application had a substantial influence on the removal of nitrogen. Seed of sunflower grown without the application of fertilizer nutrients removed 18.39 kg N ha^{-1}. The recovery of this nutrient raised significantly to 26.94 kg ha^{-1} by the application of 30 kg N ha^{-1}. The seeds removed more nitrogen with further increase in the level of fertilization. Maximum quantity of 44.55 kg ha^{-1} nitrogen was removed by the seed of sunflower heavily fertilized with 150 kg N ha^{-1}. The interactions were not significant. The sunflower seed removed nitrogen in large quantity. It was almost three times that of potassium while it removed about two times less phosphorus than potassium (Fig.2). This signifies the relative requirement of N by the crop. The seed of KBSH-1 removed more nitrogen than Morden. But, both the genotypes removed equal phosphorus and potassium. The fertilization of sunflower with 60 kg N ha^{-1} was adequate. The leaves and stem in general removed significantly more quantity of nutrients at different stages of crop growth compared to control. Similarly the seed also recovered more N at harvest due to this level of fertilization. Therefore, the application of 60 kg N ha^{-1} was the outstanding treatment to absorb adequate quantity of nutrients for the production of high seed yield. Singh *et al*. (1998) and Shaktawat and Bansal (1999) reported that the adequate removal of N through the seed is the ultimate indicator of yield potential of sunflower. They observed that N was removed in large quantities by the seed in response to the application of 80 kg N ha^{-1}. But, stem removed more nutrients by the application of 120 kg N ha^{-1} (Kumar *et al*., 1991). Kharwara and Bindra (1992) reported that under clay loam soil, the uptake of N by the sunflower was maximum by the application of 90 kg N ha^{-1}. On the other hand, Thavaprakash (2004) recorded highest uptake of N by the application of 120 kg N and 60 kg P_2O_5 ha^{-1}. The increase in the application of N, favourably increased the nutrient uptake as observed by other research workers (Khatik and Dikshit, 2001 and Reddy *et al*., 2002).

Fig. 2 : Nutrient removal by seeds (kg ha^{-1}) in sunflower genotypes – Morden and KBSH-1

Response curve for nitrogen :

Response curve plotted with incremental levels of nitrogen showed that the seed yield of Morden can be maximized by an increase in this nutrient upto 125 kg ha^{-1} and 126 kg ha^{-1} for KBSH-1 (Fig. 3). These estimated maximum

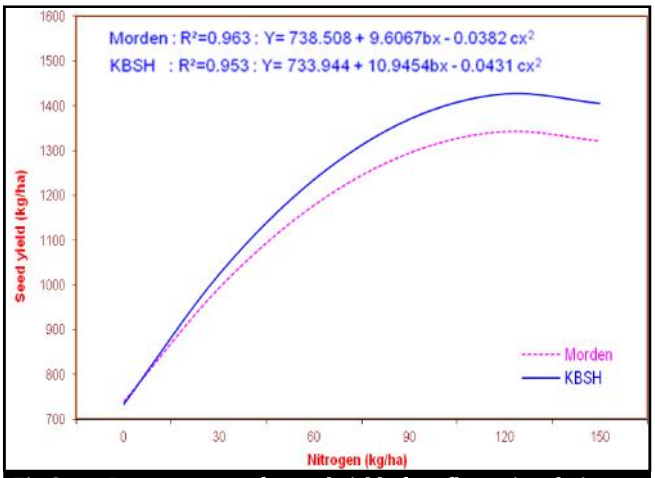

Fig. 3 : Response curve for seed yield of sunflower in relation to different levels of nitrogen per hectare

yields are possible with increasing levels of P and K. This level of fertility for increasing the yield was not significant as indicated by the variance ratio for the evaluation made by the systematic experimental design. The response curve provides a projection of increasing the production without considering the critical difference between any two treatments. Fertilizer recommendations for optimum production of sunflower seed are highly variable in literature. Aulakh *et al.* (1990) reported that the combined application of 60:60:60 kg NPK ha^{-1} was required to realize high yield of MSFH-1 genotype under rainfed conditions grown in sandy loam type of soil. Malik *et al*. (2004) obtained a significant increase in yield of sunflower (1231.4 kg ha^{-1}) by the application of 130:90:90 kg NPK ha^{-1}. While Sree *et al*. (2004) obtained high yield by the application of 60:60:30 kg NPK ha^{-1} in Vertisols. Research on the influence of increasing levels of nitrogen with fixed quantity of phosphorus and potassium revealed variable results. Singh and Bans (1999) reported that the seed yield of sunflower increased with increase in the level of fertilization up to 80 kg N ha^{-1}.

Conclusion :

The removal of N through the leaves and stem increased with increase in the level of fertilizers applied. But the trends demarcating statistical significance for a particular fertilizer schedule were not consistent from 30 DAS until harvest. The seed of sunflower removed 36.80 kg N ha^{-1} when it was fertilized with 60 kg N ha^{-1} in contrast to the low quality of 18.39 kg N ha^{-1} in control. But, maximum quantity of 44.55 kg N, was recorded by the application of 150 kg N ha^{-1} which was significantly more than the application of 60 kg N ha^{-1}.

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