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PRODUCTION POTENTIAL OF SUNFLOWER GENOTYPES UNDER VARYING FERTILITY LEVELS IN ANDHRA PRADESH

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ABSTRACT

At College of Agriculture, Rajendranagar, Hyderabad in Andhra Pradesh, a field trial was carried out during the rainy (*kharif*) season for the year 2004-05, the main aim of the research was to analyze the Production potential of two sunflower genotypes (Morden and KBSH-1) under varying fertility levels. The results of the study revealed that, among the growth characters like plant height, number of leaves, total dry matter per plant increased with increase in the fertility levels at each growth stages. Further, the results also indicated that, increases in growth characters were significantly higher in KBSH-1 when compared to Morden. The study also focus on number of seeds per capitulum (860), test weight (45.53 g), yield per plant (31.90 g) and oil yield (516 kg/ha) were observed significant in KBSH-1 genotype over Morden. However, the study also shows that, among the different fertility levels, application of 90:60:30 kg NPK/ha resulted in significantly higher plant height, higher number of leaves per plant and phytomass per plant at different growth stages and which was on-far with the application of even higher doses (150:100:50 kg) of NPK/ha. The results related to yield, shows that, the application of 60:40:20 kg NPK/ha shown significantly higher yield and yield attributing characteristics and which was on-far with the incremental increase in fertilizer application up to 150:100:50 kg NPK/ha. Oil percentage was not much varied but maximum oil out turn (524 kg/ha) was recorded with the application of 90:60:30 kg NPK/ha. Hence, the studies suggest that, agro-climatic zones with similar climatic situation may follow this pattern to increase the yield levels in sunflower.

INTRODUCTION

It is well known fact that higher grain yield depends on optimum plant density and adequate fertilizer application in particular, NPK. It is the balanced and efficient plant use of plant nutrients which is important from the point of proper growth and development of crops along with appropriate plant variety for photosynthesis and soil moisture. Therefore, matching appropriate plant variety with fertilizer schedule is essential to achieve the targeted yields. Correlating these functions to produce the highest possible yields with the greatest efficiency has been the aim of this research.

MATERIALS AND METHODS

The field experiment was conducted with two sunflower genotypes (Morden and KBSH-1) and six fertility levels (0:0:0, 30:20:10; 60:40:20; 90:60:30; 120:80:40 and 150:100:50 kg NPK ha^{-1}) was carried out in Randomized Block Design(RBD) in four replications during *Kharif* in the year 2005-06 at Agricultural College farm, Rajendranagar, Hyderabad, Andhra Pradesh (altitude of 521.0m MSL. $17^0$19'17.96 N and 78^0 25'10.92" E latitude and longitude respectively). The experimental site was sandy loam in texture having pH of 7.5, EC 0.215 dSm^{-1}, low in OC (0.4 %) and low in available N (168.9 kg ha^{-1}), medium in available P_2O_5 (23.0 kg ha^{-1}) and available K_2O (249.3 kg ha^{-1}). 484.8 mm rainfall was received in 26 rainy days from sowing to harvest. The total P and K was applied as basal dose along with ½ of nitrogen and remaining ½ was applied at 30 Days after sowing (DAS) and at bud initiation stage. The data obtained on growth and yield parameters were subjected to 2X6 factorial analysis.

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RESULTS AND DISCUSSION

Growth Characters

The sunflower genotypes, Morden and KBSH-1 had a slow growth initially during the vegetative stage at 30 days after

Table 1. Plant height (cm), number of leaves and phytomass accumulation (g/plant) of sunflower genotypes- Morden and KBSH-1as influenced by different levels of fertilizers

Treatment	Plant height (cm) DAS					Number of eaves DAS					Phytomass accumulation (g/plant) DAS				
	30	45	60	75	Harvest	30	45	60	75	Harvest	30	45	60	75	Harvest
Genotype															
Morden	21.6	60.7	97.7	100.1	100.9	13.86	19.77	23.31	12.81	5.83	8.56	45.7	83	100.3	114.9
KBSH-1	27.2	103.6	161.7	164.5	165.3	15.28	24.2	27.11	21.6	9.5	10.05	51.4	100.2	116.4	127.2
SE±	0.6	1.2	2.2	2.2	2.3	0.24	0.34	0.4	0.41	0.54	0.53	3	3	3.1	2.8
CD (P=0.05)	1.2	2.5	4.4	4.5	4.7	0.49	0.69	0.81	0.83	1.1	1.08	NS	6.1	6.2	5.7
Fertilizer (NPK kg/ha)															
0:00:00	23.5	72.3	109.3	110.4	110.8	14.25	20.9	23.57	17.75	6.87	8.05	29.8	56	59.7	66.6
30:20:10	25	79.4	124.9	127.1	127.7	14.62	21.2	23.7	17.4	7.5	9.54	40.4	82.1	95.5	105.1
60:40:20	25.2	86.6	136.7	138.6	139.7	14.65	22.45	25.65	17.4	7.62	9.53	51.9	98.4	115.4	129.2
90:60:30	24.8	86.1	136.9	139.4	139.8	14.65	22.6	25.25	17.07	7.72	8.68	56.1	103.4	126.1	136.6
120:80:40	23.4	83.9	132.7	137.3	138.2	14.65	22.2	25	17	7.75	9.41	55.7	101.8	126.2	141.5
150:100:50	24.5	84.7	137.7	141.2	142.3	14.62	22.57	25.12	16.67	8.5	10.62	57.5	107.9	127.1	147.1
SE±	1	2.2	3.8	3.9	4	0.42	0.59	0.69	0.72	0.94	0.92	5.1	5.2	5.3	4.8
CD (P=0.05)	NS	4.4	7.7	7.9	8.1	NS	1.2	1.4	NS	NS	NS	10.4	10.7	10.8	9.8
SE±	1.4	3	5.3	5.4	5.6	0.59	0.82	0.97	1.01	1.32	1.3	7.2	7.4	7.5	6.8
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	15.1	15.3	13.9

sowing (Table 1). The genotype KBSH-1 attained relatively tall height of 27.2 cm compared to 21.6cm in Morden. This was followed by rapid cell division leading to a tremendous improvement in the plant height by 45 days after sowing when the crop attained the stage of bud formation. Morden attained a mean height of 60.7 cm while, the rate of increase in plant height (103.6 cm) was more prominent in KBSH-1 owing to the hybrid vigour. This linear phase of vegetative growth from the vegetative to bud formation stage was therefore well recognized in both the genotypes. The plant height improved further with advance in age of the crop at a relatively less rapid rate indicating the senile phase of the logistic growth curve. Morden grew to a height of 97.7 cm by 60 days when the crop was in flowering stage, 100.1 cm by 75 days when the crop was in seed filling stage. There was no further vegetative growth after this stage. The genotype KBSH-1 attained a mean plant height of 161.7 and 164.5 cm at 60 and 75 days after sowing. Such a trend of improvement in plant height following a lag, linear and senile phase has also been ascertained by several workers (Gaur *et al*., 1973; Balamurugan and Angamuthu, 1999; Nayak *et al*., 2001; and Nandgopal *et al*., 2003).The mean plant height of sunflower was not influenced at 30 days after sowing due to different levels of nutrient combinations compared to control.

The application of 30: 20: 10 kg NPK/ha significantly increased the plant height of the crop from 45 days after sowing, until harvest. Fertilizers applied to supply 60 : 40 : 20 kg NPK/ha further increased the mean plant height of the crop at every stage of sampling at 15 days interval from 45 days after sowing until harvest. The interaction of fertilizer levels with the two genotypes was not significant at any stage of sampling. The two genotypes were dissimilar in producing number of leaves per plant (Table 1). Similar to these responses KBSH-1 produced more number of 15.28 leaves per plant at 30 days compared to 13.86 by Morden. This was followed a profuse development of the canopy. The leaves increased in number to 24.20 and 19.77 in the two genotypes by 45 days after sowing. This was followed by a relatively less number of addition of leaves from the bud formation to flowering stage. These were 27.11 leaves in KBSH-1 and 23.31 in Morden. The leaves then reduced to 21.60 and 12.81 by 75 days in the corresponding genotypes. At harvest, KBSH-1 retained 9.50 functional leaves per plant unlike 5.83 in Morden. This reduction in the number of leaves after flowering owes mainly to the senescence of aged leaves. This is in confirmation with the results of Thavaprakash (2004).

The crop produced significantly more number of leaves per plant at 45 and 60 days after sowing in response to the application of 60 : 40 : 20 kg NPK/ha. The effect of still high level of these nutrients was not significantly superior during these two stages. The role of fertilizer application to sunflower in increasing the number of leaves per plant has also been documented in other studies (Upadhyay *et al*., 2001). Earlier reports indicated that the production of leaves per plant of sunflower increased with increase in the level of nitrogen up to 100 kg/ha (Nagavani *et al*., 1997) and 120 kg/ha (Tomar *et al*., 1997). But few studies documented that the nitrogenous fertilizer had no influence in increasing the number of leaves compared to control (Reddy and Mohammad, 2000).The interaction of different levels of nutrients and the two genotypes of sunflower did not record any significant variation in the number of leaves per plant at any stage of crop growth.

The two genotypes recorded remarkable variation in phytomass accumulation. Morden, invariably accumulated significantly less quantity of phytomass from 30 days after sowing until harvest compared to KBSH-1 (Table.1). At harvest, Morden accumulated 114.9 g phytomass per plant in contrast to KBSH-1 which accumulated 127.2 g phytomass per plant.

Such inherent variations among the genotypes of sunflower have also been reported by Thavaprakash *et al*. (2003). Obviously, this neutral response was mainly due to the similar plant height and number of leaves produced per plant at this stage. Consequent to the development of these two parameters in the later stages from 45 days after sowing there was a significant increase in the dry weight by the application of 60:40:20 kg NPK/ha. Perhaps, this level of nutrient was adequate to manifest a remarkable improvement in the dry matter production of leaves, stem and plant. Hence, still high level of nutrients had no influence to further improve these characteristics. A large dry matter production is often correlated to improved uptake of nutrients and thereby the seed yield (Jovan *et al.*, 1999). Different levels of NPK fertilizers applied to sunflower had no significant influence on phytomass accumulation per plant compared to control at 30 days after sowing. But, the crop nurtured with a low level of 30:20:10 kg NPK/ha significantly increased the phytomass from 45 days after sowing until harvest. The effect of application of 60:40:20 kg NPK/ha was more pronounced in the later stages. There was no further advantage of high level of nutrients on phytomass accumulation at 45 and 60 days after sowing. The phytomass accumulated due to the

application of 150:100:50 kg NPK/ha was on par with the effect of 60:40:20 kg NPK/ha. However, still high level of 90:60:30 kg NPK/ha significantly increased the phytomass per plant at 75 days after sowing. But, the application of 120:80:40 kg NPK/ha significantly increased phytomass compared to the effect of 60:40:20 kg NPK/ha at harvest. There was a significant interaction on the phytomass accumulation due to the two genotypes and different levels of fertility at 60, 75 days after sowing and at harvest (Table 2a, 2b, 2c). The genotype KBSH-1 accumulated significantly large quantity of phytomass per plant than Morden when they were grown without the addition of fertilizers and when supplied with a low nutrient level of 30:20:10 kg NPK/ha. Further, increase in the level of fertilizer nutrient additions, the two genotypes accumulated the phytomass on par with each other. This trend was persistent at 60, 75 days after sowing and at harvest. The beneficial effect of nitrogen in improving the vegetative growth in terms of plant height and number of leaves is well established due to its functional involvement in rapid cell division and elongation, photosynthesis and translocation of photosynthates. In general, phosphorus and potassium have relatively less influence in promoting the vegetative growth of the crop. But, the synergistic effect of these nutrients with nitrogen in increasing the plant height and number of leaves per plant of sunflower has been ascertained by Kumar and Reddy (1997); and Upadhyay *et al.*, (2001).

Table 2a. Interaction of genotypes and nutrient levels on phytomass accumulation (g/plant) at 60 days of sunflower crop

Treatment	Fertilizer (NPK kg/ha)					
	0:0:0	30:20:10	60:40:20	90:60:30	120:80:40	150:100:50
Genotype						
Morden	38.3	64.7	95.3	98.0	95.5	106.1
KBSH-1	73.6	99.5	101.6	108.8	108.0	109.7

Table 2b. Interaction of genotypes and nutrient levels on phytomass accumulation (g/plant) at 75 days of sunflower crop

Treatment	Fertilizer (NPK kg/ha)					
	0:0:0	30:20:10	60:40:20	90:60:30	120:80:40	150:100:50
Genotype						
Morden	46.3	77.5	110.7	119.3	124.6	123.5
KBSH-1	73.1	113.5	120.2	133.0	127.7	130.7

Table 2c. Interaction of genotypes and nutrient levels on phytomass accumulation (g/plant) at harvest of sunflower crop

Treatment	Fertilizer (NPK kg/ha)					
	0:0:0	30:20:10	60:40:20	90:60:30	120:80:40	150:100:50
Genotype						
Morden	53.2	87.9	126.3	136.1	139.0	146.8
KBSH-1	80.0	122.2	132.1	137.2	144.1	147.5

Yield Attributes

There were no apparent differences in the capitulum diameter between the two genotypes (Table.3). But, the number of seeds accommodated was significantly more in KBSH-1 than Morden. KBSH-1 measured 14.31 cm. But, it had significantly more number of 860 seeds, a heavy test weight of 45.53 g and more seed yield of 31.90 g per plant and Morden had a mean capitulum diameter of 14.69 cm. It had a mean of 697 seeds per capitulum. The test weight of thousand seed was 41.30 g. The seed yield was 26.71 g seed per plant. The visual observations substantiate the reason for this variation that the seed of Morden were bold with larger width. The seed of KBSH-1 were thin and long in shape but with compact filling of kernels in the hulls. Hence the seed of this genotype were heavy in weight. This is indicated by a significantly higher test weight. The large size of seed of Morden acquired more space per capitulum of same size as KBSH-1 and thereby the number of seeds was less. Also the seed filling was not compact. A gap between the hull and kernel was clearly felt. Hence, its weight was also less. All these parameters recorded a significant improvement by fertilizing the crop with 30:20:10 kg NPK/ha. The crop had a larger capitulum diameter of 13.45 cm, produced more number of 629 seeds with an enormous increase in the test weight to as high as 40.32 g and eventually a substantial increase in yield to 24.65 g per plant. An increase in the level of fertilizer application to 150:100:50 kg NPK/ha increased the size of the capitulum to 16.69 cm producing 893 seeds and maximizing the test weight to 48.96 g thereby, yielding a maximum of 35.53 g seed per plant. However, this high level of fertilization was significantly superior only to the effect of 30:20:10 kg NPK/ha on the number of seeds and seed yield per plant and to the effect of 60:40:20 kg NPK/ha on the test weight of seed. The application of 60:40:20 kg NPK/ha significantly increased the capitulum diameter and thereby provided a larger space which accommodated significantly more number of seeds resulting in a significant increase in seed yield per plant.

Yield

The sample of sunflower recorded a significantly more yield of 31.90 g per plant in KBSH-1 compared to 26.71 g in Morden (Table.4). This statistical significance was not reflected in yield per hectare although the hybrid recorded 55 kg more yield over 1144 kg from Morden. This trend could possibly be attributed to the sample size which was perhaps inadequate to match with the statistical evaluation of yield per hectare from the population. Singh *et al.* (2000) also reported that the hybrid MSFH-8 produced more number of seeds per capitulum. They also recorded large capitulum size of the hybrid and more seed yield per hectare. The seed yield per hectare was remarkably influenced by the level of fertilizer nutrient applied. Maximum seed yield of 1388 kg/ha was reaped from the crop fertilized with 150:100:50 kg NPK/ha. The crop produced 1343 kg seed yield per hectare by the application of 90:60:30 kg NPK/ha and 1335 kg/ha by the application 120:80:40 kg NPK/ha. This was on par with the seed yield realized by the application of 150:100:50 kg NPK/ha. The moderate dose of 60:40:20 kg NPK/ha enabled

Table 3. yield attributes of sunflower genotypes - Morden and KBSH-1 as influenced by different levels of fertilizers

Treatment	Capitulum diameter (cm)	Number of seeds/head	Yield/plant (g)	Test weight (1000 seeds) (g)
Genotype				
Morden	14.69	697	26.71	41.30
KBSH-1	14.31	860	31.90	45.53
SE±	0.50	29	1.57	1.02
CD (P=0.05)	NS	59	3.20	2.08
Fertilizer (NPK (kg/ha)				
0:0:0	10.81	522	15.96	31.93
30:20:10	13.45	629	24.65	40.32
60:40:20	14.80	821	31.49	44.19
90:60:30	15.60	891	34.29	47.81
120:80:40	15.65	866	33.93	47.28
150:100:50	16.69	893	35.53	48.96
SE±	0.87	50	2.72	1.77
CD (P=0.05)	1.77	102	5.55	3.61
Interaction				
SE±	1.22	71	3.84	2.49
CD (P=0.05)	NS	NS	NS	NS

Table 4. Seed yield, oil per cent and oil yield of sunflower genotypes – Morden and KBSH-1 as influenced by different levels of fertilizers

Treatment	Seed yield (kg/ha)	Oil	
		Per cent	kg/ha
Genotype			
Morden	1144	32.70	374
KBSH-1	1199	43.13	516
SE±	49	1.09	23
CD (P=0.05)	NS	2.22	48
Fertilizer (NPK kg/ha)			
0:0:0	717	38.28	274
30:20:10	1035	38.06	396
60:40:20	1209	38.28	463
90:60:30	1343	38.09	524
120:80:40	1335	39.98	499
150:100:50	1388	36.79	515
SE±	85	1.88	40
CD (P=0.05)	173	NS	83
Interaction			
SE±	120	2.66	57.1
CD (P=0.05)	NS	NS	NS

the crop to produce 1209 kg/ha seed yield. This was significantly more than the seed yield of 1035 kg/ha realized by the application of a low level of 30:20:10 kg NPK/ha. The unfertilized crop produced significantly least yield of 717 kg seed per hectare. Interactions were not significant to exert remarkable variation in the response pattern of seed yield of the two genotypes due to different levels of fertility. The genotype KBSH-1 produced substantially large quantity of 516 kg oil/ha. Morden yielded significantly low quantity of 374 kg oil/ha. Sunflower grown on native soil fertility produced mean oil yield of 274 kg/ha. The application of fertilizers increased the oil yield remarkably. The application of 30:20:10 kg NPK/ha significantly enhanced the oil yield to 396 kg/ha. The best impact was detected by the application of 90:60:30 kg NPK/ha. The crop produced maximum oil yield of 524 kg/ha. The oil yield did not increase with further increase in the level of fertilization. Sunflower is a crop of reputedly high quality oil for human health. Hence, its oil content fetch differential premium in the market. The seed of KBSH-1 had a high oil content of 43.13 per cent compared to 32.70 per cent in Morden. Although the differences in the seed yield of the two genotypes were not significant, the high oil percentage in KBSH-1 was reflected in additional production of 142 kg oil per hectare. This difference is highly luring which makes a dent in the option to be exercised for KBSH-1 than Morden. But, this merit is also associated with few disadvantages. Early duration of the crop is the most desirable characteristic under rainfed conditions. This will minimize the risk of terminal moisture stress. Despite, its high oil content the genotype KBSH-1 run the risk of terminal moisture stress due to its long time to mature in 110 days compared to early maturity of Morden in 95 days. The high sale price of seed of KBSH-1 owing to its rich oil content holds promise for disposal in the market. But, if the farmer desire to produce seed for multiplication Morden is the best option. Several research workers also reported that the oil content increased with increase in the fertilizer application (Rajendran and Veeraputhiran, 2001). Malik *et al*. (2004) also reported that the hybrids are not only rich in oil content but also produce more oil yield per hectare. The interaction between the two genotypes and the six levels of fertilizer nutrients did not execute a significant effect.

Summary

The genotype, KBSH-1 had a vigorous growth. It attained significantly tall height produced more number of leaves per plant and accumulated large quantity of phytomass compared to Morden from the vegetative phase until the maturity of the crop. The capitulum of KBSH-1 had more number of seeds primarily due to the narrow shape unlike the wider width of seed of Morden. The kernels developed compact within the hulls of sunflower achenes and hence recorded a higher test weight. Therefore, KBSH-1 produced more seed yield per

plant. Fertilizer application improved the vegetative crop growth, nutrient uptake, yield components and yield of sunflower. This impact on vegetative crop growth was significant from 45 days after sowing. The crop fertilized with 60:40:20 kg NPK/ha significantly increased the plant height at every stage of crop growth from 45 days after sowing until harvest. This was on par with still high level of nutrients upto 150:100:50 kg NPK/ha. This trend was also similar on number of leaves per plant at 45 and 60 days after sowing. There was no significant difference in the number of leaves retained per plant later at 75 days after sowing and at harvest. The dry weight of phytomass per plant was also significantly enhanced by this nutrient level from 45 days until harvest of the crop. The capitulum diameter increased progressively with incremental increase in the level of these nutrients up to 60:40:20 kg NPK/ha. But, the effect of increasing levels of NPK from 90:60:30 to 150:100:50 kg/ha was on par. Significantly more number of seeds/capitulum was produced by the application of 60:40:20 kg NPK/ha. The per hectare production raised from a bare low of 717 kg/ha in control to as high as 1209 kg/ha in response to the application of 60:40:20 kg NPK/ha.

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