HELIA, **28**, Nr. 43, p.p. 135-144, (2005) UDC 633.854.78:631.52

EFFECT OF NUTRIENTS AND MOISTURE CONSERVATION PRACTICES ON GROWTH, YIELD AND ECONOMICS OF SUNFLOWER (*Helianthus annuus* L.) GROWN ON RAINFED VERTISOLS IN SEMIARID TROPICS

B.N. Reddy*, H.T. Chandranath, Y. Muralidharudu, K.R. Lokesha and P. Murali Arthanari

Directorate of Oilseeds Research, Rajendranagar, Hyderabad, Andhra Pradesh – 500 030, India

Received: August 10, 2004
Accepted: November 22, 2005

SUMMARY

On-farm trials were conducted during 2001 and 2002 rainy seasons to evaluate the effects of nutrients and moisture conservation practices on the growth, yield and economics of sunflower (*Helianthus annuus* L.) cultivars grown on vertisols of Raichur district, Karnataka, India, under rainfed conditions. Two-year results revealed that the recommended method of moisture conservation along with the recommended fertilizer practice gave significantly higher seed yield (994 kg/ha), net returns (Rs.10503/ha) and cost-benefit ratio (2.62) than the conventional method of moisture conservation and fertilizer practices. Also, the former method surpassed the latter in plant height, head size, stem thickness and 1000-seed weight. The hybrid KBSH-44 showed significantly favorable responses with respect to growth and yield components. It gave higher yield (993 kg/ha), net returns (Rs.10222/ha) and cost-benefit ratio (2.84) than the hybrids KBSH-1 and MSFH-17 when grown on vertisols under rainfed conditions.

Key words: sunflower, nutrient, moisture, vertisols

INTRODUCTION

Sunflower (*Helianthus annuus* L.) was introduced as an oil seed crop in India during 1970s. It gained popularity and importance in Karnataka state for growing as a commercial oilseed crop under rainfed conditions. This was due to its suitability to the diverse agroecological regions of the state, short duration, good oil quality and attractive market price. Although it is mainly cultivated in rainy season, it can be grown in any season of the year since it is considered as day neutral plant

* Corresponding author

because of its low photoperiod sensitivity. The rainfed sunflower crop exhibits wide fluctuations in productivity due to erratic rainfall distribution and low availability of nutrients. In Karnataka, this crop occupies an area of 1,335,000 ha producing 733,000 t with the productivity of 549 kg/ha. Karnataka, Andhra Pradesh, Maharashtra and Tamil Nadu are the traditional sunflower-growing states among which Karnataka occupies 47% of the area and contributes 30% to the total production (Damodaram and Hegde, 2002). Though the crop has gained importance among farmers, the productivity of sunflower is very low. The low productivity is mainly due to crop growing under rainfed conditions on poor soils and non-availability of cultivars tolerant to moisture and nutrient stress situations. This crop is often considered as a soil nutrient-depleting crop, which puts heavy demands on soil and applied nutrients (Thavaprakash *et al.*, 2002). Due to its high nutrients uptake, sunflower responds very well to nutrients application. Application of nutrients increased the sunflower seed yield by 50% (Chorey and Thosar, 1997).

The rainfed sunflower experiences erratic and undependable rainfall, moisture excess and deficit, within the same season. The farmers of the investigated region are resource poor and use very little fertilizer. Identification of cultivars suited to moisture and stress conditions is vital for the farmers of this region. Hence, performance of three sunflower cultivars was evaluated to identify most suitable cultivar for moisture and nutrient stress situations.

MATERIAL AND METHODS

On-farm experiments were conducted during the rainy seasons (June to October) of 2001 and 2002 in Raichur district in Karnataka, India, to study the performance of sunflower cultivars when grown under moisture and nutrient constraints on vertisols in semiarid tropics. The field experiments were conducted under rainfed conditions. The experimental sites in the two years covered three villages (Shakavadhi, Gunjelli and Manjerla, Raichur district) whose fields varied in soil fertility. The soils of the experimental field in the two years were sandy clay to clay with pH ranging from 8.0 to 8.7, organic carbon from 0.37 to 0.61%, available phosphorus from 3 to 21 kg/ha and available potassium from 293 to 588 kg/ha. The soils had field water capacity from 16.6% to 28.2% and permanent wilting point from 7.47% to 13.1% with available water holding capacity of 10.24 to 16.96 cm at 75 cm depth. The potential hybrid KBSH-44, the recommended hybrid KBSH-1 and the check hybrid MSFH-17 were tested under conventional and recommended methods of moisture conservation in combination with either conventional or recommended fertilizer application. The experiment was laid out in a split plot design, with combinations of three moisture conservation and fertilizer practices as main plot (Table 1) and three cultivars (KBSH-44, KBSH-1 and MSFH-17) as subplots, having three replications in the two years, considering each farmer as a replication.

Moisture conservation practices under the conventional method comprised of repeated harrowing and two between-row cultivations. The recommended method of moisture conservation consisted of key line cultivation and opening the furrow between two rows 30-35 days after sowing. Fertilizer treatment consisted of recommended dose of fertilizer (35:50:35 kg N, P_2O_5, K_2O/ha) and conventional fertilizer practice (17.5:25:17.5 kg N, P_2O_5, K_2O/ha). All NPK fertilizers were applied at the time of sowing. The crop was sown at a spacing of 60 x 30 cm from last week of June to 15 July each year. The plot size for each treatment was 300 m^2. The rainfall received during cropping period was 623.6 mm in 2001 and 473.2 mm in 2002. These amounts were considered to be less than normal rainfall. Observations were recorded for growth dynamics, yield components and total yield. Economics were computed based on the prevailing market price. The oil content of sunflower seed was estimated using the nuclear magnetic resonance (NMR) method (Model Oxford mQA 6005).

RESULTS AND DISCUSSION

Growth and yield components

The obtained data revealed that during the rainy season of 2001 the recommended moisture conservation practice along with the recommended dose of fertilizer recorded significantly higher plant height, larger head size, increased stem girth and higher 1000-seed weight than the conventional method of moisture conservation and fertilizer application (Table 1). During 2002, similar trends were again observed for all these characters.

The pooled two-year data gave higher values of growth and yield components with the recommended moisture conservation and fertilizer practice than with the conventional method. The data on growth dynamics and yield components of KBSH-44 revealed that it produced significantly high values of plant height, head diameter, stem girth and 1000-seed weight than KBSH-1 and MSFH-17 in both years. There was no significant difference between KBSH-1 and MSFH-17 with respect to plant height, head diameter, stem girth and 1000-seed weight.

Seed and oil yield

During the rainy seasons of 2001 and 2002, the sunflower seed yields differed significantly due to different moisture conservation and fertilizer practices (Table 2). The recommended method of moisture conservation in combination with the recommended fertilizer practice recorded seed yields of 880 kg/ha and 1188 kg/ha in 2001 and 2002, respectively. These yields were significantly higher than those obtained with the conventional moisture conservation and fertilizer practices, which amounted to 586 kg/ha and 767 kg/ha, respectively. The magnitudes of increase in seed yield of sunflower grown under the recommended method of mois-

Table 2: Effect of moisture conservation and fertilizer on seed and oil yield of *rainy season* sunflower cultivars

Treatment	Seed yield (kg/ha)			Oil content (%)			Oil yield (kg/ha)		
	2001	2002	Pooled	2001	2002	Pooled	2001	2002	Pooled
Moisture conservation and fertilizer practice (M)									
Conventional method MC +FA	586	767	785	24.5	35.8	30.2	189	274	231
Conventional method MC +RDF	717	848	796	28.9	36.0	32.5	212	304	258
RMC + RDF	880	1188	994	30.4	35.7	33.0	234	427	330
SEm±	29.1	72.8	30.6	3.36	0.56	1.46	17.0	27.6	11.1
CD (P = 0.05)	89.5	285.3	88.3	NS	NS	NS	NS	107.2	31.9
Cultivar (C)									
MSFH –17	663	789	774	22.4	30.3	26.4	166	234	200
KBSH –1	726	941	809	34.4	44.6	39.5	228	418	323
KBSH – 44	794	1074	993	27.1	32.6	29.8	241	353	297
SEm±	7.50	35.4	30.6	26.0	0.92	1.46	9.12	15.1	11.1
CD (P=0.05)	21.5	109.2	88.3	7.99	2.8	4.22	28.0	47.0	31.9
M X C									
SEm±	30.9	88.4	53.1	1.05	1.41	2.54	21.4	34.7	19.2
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
C X M									
SEm±	13.0	61.5	-	1.07	1.56	-	15.8	26.2	-
CD (P=0.05)	NS	NS	-	NS	NS	-	NS	NS	-

MC = moisture conservation, FA = fertilizer application, RMC = recommended method of moisture conservation,
RDF = recommended dose of fertilizer, M = moisture, C = cultivar

Table 1: Effect of moisture conservation and fertilizer on the performance of growth and yield components of *rainy season* sunflower cultivars

Treatment	Pl. ht. at harvest (cm)			Stem girth (cm)			Head diameter (cm)			1000 Seed weight (g)		
	2001	2002	Pooled	2001	2002	Pooled	2001	2002	Pooled	2001	2002	Pooled
Moisture conservation and fertilizer practice (M)												
Conventional method MC +FA	102.0	82.5	92.2	7.8	4.5	4.7	9.9	9.2	9.55	35.0	41.5	38.3
Conventional method MC +RDF	115.5	95.1	105.3	5.2	5.2	5.2	11.5	10.2	10.86	33.3	43.8	38.6
RMC + RDF	126.2	107.6	116.9	5.6	5.7	5.7	12.9	11.6	12.3	30.8	45.4	38.1
SEm±	0.46	53.7	1.08	0.07	0.07	0.07	0.42	0.57	0.25	2.33	0.57	1.15
CD (P = 0.05)	1.83	NS	3.11	0.23	0.3	0.22	1.63	NS	0.73	NS	2.3	NS
Cultivar (C)												
MSFH –17	99.6	84.1	91.9	4.7	5.0	4.9	9.9	9.9	9.93	34.4	42.9	38.6
KBSH –1	104.3	191.3	100.5	5.2	5.1	5.2	10.4	10.4	10.42	27.5	43.6	35.6
KBSH – 44	139.9	104.4	122.1	5.7	5.3	5.5	13.9	10.7	12.31	37.2	44.2	40.7
SEm±	1.44	55.0	1.08	0.07	0.02	0.08	0.41	0.08	0.25	2.27	0.21	1.16
CD (P=0.05)	4.41	NS	3.11	0.21	0.08	0.23	1.27	0.26	0.73	7.00	0.7	3.33
M X C												
SEm±	2.08	94.6	1.87	0.13	0.08	0.13	0.71	0.59	0.43	3.97	0.64	2.0
CD (P=0.05)	6.49	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C X M												
SEm±	2.48	95.3	-	0.13	0.04	-	0.71	0.14	-	3.93	0.35	-
CD (P=0.05)	7.65	NS	-	NS	NS	-	NS	NS	-	NS	NS	-

MC = moisture conservation, FA = fertilizer application, RMC = recommended method of moisture conservation, RDF = recommended dose of fertilizer, M = moisture, C = cultivar

ture conservation in combination with the recommended fertilizer practice over the conventional method of moisture conservation in combination with the recommended fertilizer practice and the conventional practice of moisture conservation and the conventional fertilizer application were 22.7% and 50.2%, respectively, in 2001 and 10.6% and 54.9%, respectively, in 2002. The oil content of sunflower was greatly influenced by management practices. The recommended moisture conservation in combination with the recommended fertilizer practice and the conventional method of moisture conservation in combination with the recommended fertilizer practice were similar in the obtained values of oil content. A significant difference in oil yield was registered in 2002.

The pooled two-year data (Table 2) revealed that the seed yield, oil content and oil yield of sunflower were significantly influenced by the combination of recommended moisture conservation and recommended fertilizer dose. The recommended management practices resulted in improved seed yield (994 kg/ha), which was higher by 27% (785 kg/ha) and 25% (796 kg/ha) than the yields obtained with the conventional method of moisture conservation in combination with the conventional fertilizer application and the conventional method of moisture conservation in combination with the recommended fertilizer dose, respectively. The various moisture conservation and fertilizer practices did not vary much in oil content. However, the recommended moisture conservation and fertilizer practices gave higher oil yield (330 kg/ha) than the conventional method (231 kg/ha). This might be due to a more efficient utilization of moisture from deeper layers during dry spells in addition to the availability of adequate nutrients in the root zone. Favorable response of sunflower hybrids to fertilization in the presence of adequate moisture has been observed by Megur *et al.* (1993) and Devidayal and Agarwal (1998).

The seed yield of sunflower differed significantly with different cultivars. In 2001, the hybrid KBSH-44 recorded a significant seed yield (794 kg/ha) followed by KBSH-1 (726 kg/ha). MSFH-17 had the lowest seed yield. Superior performance of KBSH-44 was also observed in 2002 and it was confirmed on the basis of pooled data.

The magnitude of yield increase of KBSH-44 over KBSH-1 and MSFH-17 was 9.4% and 14.13% in 2001, and 19.8% and 36.12% in 2002, respectively. In 2001, KBSH-1 recorded higher oil content (34.4%) than KBSH-44 (27.8%) and these hybrids were superior to MSFH-17, which had the lowest oil content of 22.4%. During the rainy season of 2002, KBSH-1 recorded a significantly higher oil content (44.6%) than MSFH-17 (30.3%) and KBSH-44 (32.6%). Significant differences with respect to oil yield were observed among the cultivars, with KBSH-44 and KBSH-1 recording similar oil yields which were superior to that of MSFH-17.

The rainfed sunflower is sometimes more hungry than thirsty, which adds to its low productivity. There is a strong interaction between fertilizer application and moisture availability which affects crop yield. Application of nutrients facilitates root growth, which are then capable of extracting moisture from deeper soil layers.

Furthermore, application of fertilizers facilitates an early development of the canopy that covers the soil and intercepts more solar radiation and thereby reduces the evaporation component of evapotranspiration. In this study, differential response of sunflower cultivars was observed with respect to moisture and nutrient management practices during the rainy seasons of 2001 and 2002. The pooled data for the two seasons revealed that the hybrid KBSH-44 brought a substantially higher seed yield (993 kg/ha) than KBSH-1 (809 kg/ha) and MSFH-17 (774 kg/ha). The percents of increase in seed yield by KBSH-44 over KBSH-1 and MSFH-17 were 22.7% and 28.3%, respectively. The superior yield performance of KBSH-44 could be attributed to enhanced growth in terms of plant height, larger head size having more seeds and higher test weight as compared with KBSH-1 and MSFH-17. Benefits of soil moisture conservation and fertilizer application in KBSH-44 during post rainy season are also reported by Reddy *et al.* (2003).

The tested moisture conservation and fertilizer practices were found to be non-significant with respect to their effects on seed yield.

Economics

The mean two-year data pertaining to gross returns, net returns, B:C ratio and additional net returns over control are presented in Table 3.

Table 3: Economics of sunflower cultivars under variable moisture and nutrient conditions (mean of 2001 and 2002)

Treatment	Gross returns (Rs/ha)	Net returns (Rs/ha)	Additional net returns over conventional practice (Rs/ha)	B:C ratio
Moisture conservation and fertilizer practice (M)				
Conventional method MC + FA	11102	6338	-	2.33
Conventional method MC + RDF	12800	6601	263	2.06
RMC + RDF	17003	10096	3758	2.62
Cultivar (C)				
MSFH –17	11872	5930	-	2.0
KBSH –1	13677	7898	1968	2.37
KBSH – 44	15357	10222	4292	2.84

MC = moisture conservation, RMC = recommended method of moisture conservation, FA= fertilizer application, RDF = recommended dose of fertilizer

The maximum gross return of Rs.17003/ha was recorded with the recommended method of moisture conservation and the recommended dose of fertilizer. The lowest gross return (Rs.11102/ha) was recorded under the conventional method of moisture conservation and fertilizer. Among the cultivars, maximum gross return (Rs.15357/ha) was recorded with KBSH-44. The recommended method of moisture conservation and the recommended fertilizer recorded significantly higher net returns (Rs.10096/ha) and B:C ratio (2.62) than the other treat-

ments, while the conventional method of moisture conservation and fertilization recorded lowest net returns (Rs.6338/ha) and B:C ratio (2.33). Among the cultivars, KBSH-44 recorded significantly higher net returns (Rs.10222/ha) and B:C ratio (2.84) compared with KBSH-1 and MSFH-17.

The additional net returns obtained with the recommended method of moisture conservation in combination with the recommended fertilizer was Rs.3758/ha over the conventional method of moisture conservation and conventional fertilizer practice. KBSH-44 and KBSH-1 gave additional net returns of Rs.4292/ha and Rs.1968, respectively, over MSFH-17.

The higher gross returns, net returns and B:C ratio of the recommended methods of moisture conservation and fertilizer practice might be due to higher seed yield coupled with higher market price during both years.

CONCLUSION

The results of the two-year experiment clearly indicated that adoption of the recommended method of moisture conservation (key line cultivation and furrow opening between rows 30-35 days after sowing) and the recommended dose of fertilizer (35:50:35 kg N, P_2O_5, K_2O/ha) proved to be best for the cultivar KBSH-44 grown on vertisols of semi arid tropics of Karnataka (India) regarding yield performance and financial returns.

ACKNOWLEDGEMENTS

The financial support received by the National Agricultural Technology Project under Rainfed Oilseeds Production System (Project Code: ROPS-12) is gratefully acknowledged.

REFERENCES

Acharya, C.L., 2002. Integrated input management for sustainable crop production in rainfed agro – ecosystems. J. Indian Society of Soil Science 50(4): 398-413.

Chorey, A.B. and Thosar, V.R., 1997. Effect of individual production factors on yield of *rabi* sunflower. PKV Res. J. 21: 169-170.

Damodaram, T. and Hegde, D.M., 2002. Oilseeds situation: A statistical compendium 2002. Directorate of Oilseeds Research, Hyderabad, pp: 154.

Devidayal and Agarwal, S.K., 1998. Response of sunflower (*Helianthus annuus* L.) to organic manures and fertilizers. Indian Journal of Agronomy 43(3): 469-473.

Megur, N.C., Prabhakar, A.S., Hosmani, N.I. and Kalghatagi, S.B., 1993. Effect of nitrogen and phosphorus on growth and yield of sunflower. Journal of Oilseeds Research 10(1): 127-128.

Reddy, B.N., Chandranath, H.T., Lokesha, K.R. and Muralidharudu, Y., 2003. Effect of nutrients and moisture conservation practices on growth, yield and economics of *rabi* sunflower under rainfed vertisols. J. of Oilseeds Research 20(2): 244-248.

Thavaprakash, N., Sivakumar, S.D., Raja, K., and Senthil Kumar, G., 2002. Effect of nitrogen and phosphorus levels and ratios on seed yield and nutrient uptake of sunflower hybrid DSH-1. Helia 25(37): 59-68.

INFLUENCIA DEL NUTRIENTE Y LAS MEDIDAS DE MANUTENCIÓN DE HUMEDAD EN EL CRECIMIENTO, RENDIMIENTO Y ECONOMICIDAD DE GIRASOL (*Helianthus annuus* L.) CULTIVADO EN VERTISOL EN LAS CONDICIONES DE LABRANZA SECA EN LAS REGIONES TROPICALES SEMIÁRIDAS

RESUMEN

Los experimentos de campo se realizaban durante las temporadas de lluvia en los años 2001 y 2002, para evaluar la influencia de los nutrientes y las medidas aerotécnicas para el mantenimiento de la humedad en el crecimiento, rendimiento y economicidad de las variedades de girasol, *Helianthus annuus* L., cultivado en vertisoles en la región de Raichur (Karnataka), La India, en las condiciones de labranza seca. Los resultados de dos años, demostraron que el método de mantenimiento de humedad recomendado, junto con el método de fertilización recomendado, dio significativamente más alto rendimiento de semilla (994 kg/ha), ingreso neto (10503 riales/ha) y relación entre los ingresos y gastos (2.62) que el método granjero convencional de mantenimiento de humedad y fertilización. El método integral de mantenimiento de la humedad y fertilización recomendado dio las plantas más altas, mayores cabezas, el tallo más gordo y mayor peso de 1000 granos. El híbrido KBSH-44 demostró la reacción significativamente favorable en cuanto al crecimiento y componentes del rendimiento. Él tuvo el rendimiento (993 kg/ha) y el ingreso neto (10222 riales/ha) más altos, con una relación más favorable entre los ingresos y gastos (2.84) de los genotipos KBSH-1 y MSFH-17 en las condiciones de cultivo en vertisoles.

EFFET DES NUTRIMENTS ET DES MESURES DE CONSERVATION DE L'HUMIDITÉ SUR LA CROISSANCE, LE RENDEMENT ET L'ÉCONOMIE DU TOURNESOL (*Helianthus annuus* L.) CULTIVÉ SUR VERTISOL ALIMENTÉ PAR LA PLUIE DANS LES ZONES TROPICALES SEMI-ARIDES

RÉSUMÉ

Des expériences sur le terrain ont été effectuées pendant deux ans durant la saison des pluies de 2001 et de 2002 dans le but d'évaluer l'effet des nutriments et des mesures de conservation de l'humidité sur la croissance, le rendement et l'économie du tournesol, *Helianthus annuus* L., sur les vertisols du district de Raichur (Karnataka), en Inde dans les conditions d'alimentation par la pluie. Les résultats de ces deux années ont démontré que la méthode recommandée pour la conservation de l'humidité et la méthode recommandée pour la fertilisation avaient donné un plus grand rendement en graines (994kg/ha), un revenu net plus important (10503 rials/ha) et un plus grand bénéfice : rapport de coût (2.62) que les méthodes conventionnelles des agriculteurs. La méthode intégrale de conservation de l'humidité et de fertilisation recommandée avait donné plus de plantes, des têtes plus grandes, une tige plus épaisse et un plus grand poids de 1000 graines. L'hybride KBSH-44 a montré une réaction significativement plus favorable pour ce qui est de la croissance et

des composants du rendement. Il avait un plus grand rendement (993 kg/ha) et un meilleur revenu net (10222 rials/ha) en plus d'un meilleur bénéfice, rapport de coût (2.84) que les génotypes KBSH-1 et le MSFH-17 sur des vertisols alimentés par la pluie.