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Agronomic Performance of Sunflower (Helianthus annuus L.) to Different Levels of Nitrogen, Sulphur and Farmyard Manure under Temperate Conditions

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Abstract
A field study was conducted to ascertain the impact of nitrogen, sulphur and farmyard manure (FYM) on development dynamics and yield of sunflower (*Helianthus annuus* L.). Application of 120 kg N ha^{-1} significantly increased all the yield components *viz.*, plant height, leaf area index, dry matter production, capitulum diameter, achenes $capitulum^{-1}$ and 1000-seed weight during two years of experimentation. Pooled seed yield over two years and for individual year's also recorded significant increase, however 80 and 120 kg N ha^{-1} were statistically similar. The oil content showed consistent decrease with increase in nitrogen levels, whereas oil yield showed significant improvement with increase in nitrogen application up to 120 kg ha^{-1} during both years. Sulphur application at 60 kg ha^{-1} significantly increased plant height, leaf area index and dry matter production at various crop growth periods except at 25 DAS over 30 kg S ha^{-1}.All yield contributing characters viz., total achenes $capitulum^{-1}$, filled achenes $capitulum^{-1}$, head diameter and 1000-seed weight recorded significance with sulphur application at 60 kg ha^{-1} over 30 kg S ha^{-1} during both years of experimentation. However sterility percentage remained unaffected with different sulphur levels. Seed and stalk yield during 2009 and 2010 and pooled seed yield over two years recorded with 60 kg S ha^{-1} was significantly higher than 30 kg S ha^{-1}. Both oil content and oil yield recorded significant improvement with increase in sulphur application from 30 to 60 kg S ha^{-1}. FYM application at 10 and 20 t ha^{-1}, at par with one another, recorded significant improvement in the plant height, leaf area index and dry matter production of sunflower at various crop growth periods except at 25 DAS over no FYM application during both years of experimentation. Seed yield over two years recorded with 10 and 20 t FYM ha^{-1} was at par but significantly higher than no FYM application. However, the stalk yield showed significant and consistent increase with increase in FYM rate up to 20 t ha^{-1}. Oil content remained unaffected by different FYM levels during both years of experimentation. However, oil yield increased significantly and consistently with increase in FYM levels up to 20 t ha^{-1}.
Keywords: FYM, Sulphur, Sunflower, Nitrogen, Yield.

INTRODUCTION

Sunflower (*Helianthus annuus* L.), an important oilseed crop contains a good percentage of oil, protein and crude fibre (Table 1). Its short duration and photo-insensitivity, suits well to rainy season (Thimmegowda *et al.,* 2007). In India, it is cultivated over an area of about 2.4 million hectares with the production of 1.44 million tonnes (Anonymous, 2008). It was a recent introduction in Kashmir valley as an oilseed crop, where hardly any oilseed crop is cultivated in *kharif* season. Nitrogen is the most important limiting nutrient required by the plant. It helps in the early growth, better assimilation of carbohydrates and synthesis of proteins and as such must be supplied throughout the growth period of the crop. It also affects the seed quality by increasing proteins and decreasing oil concentration (Gudade *et al.,* 2009). Sulphur is increasingly being recognized as the fourth major plant nutrient after nitrogen, phosphorus and potassium (Tandon and messick, 2002). It helps in the synthesis of cystein, methionine, chlorophyll, vitamins (B, biotin and thiamine), metabolism of carbohydrates, oil content, protein content and also associated with growth and metabolism, especially by its effect on the protolytic enzymes (Najar *et al.,* 2011). For higher productivity and sustainability, integrated use of organic and inorganic sources of nutrients is very important (Sharma *et al.,* 2008). In view of these the present investigation was carried out to chalkout the Agronomic performance of sunflower (*Helianthus annuus* L.) to different levels of nitrogen, sulphur and farmyard manure under temperate conditions

Table 1: Composition of sunflower seed

Constituent	Composition (Percent)
Hull	21-27
Oil	48-53
Protein	14-19
Soluble sugar	7-9
Crude fibre	16-27
Ash	2-3

Source: Nagraj, 1995

MATERIALS AND METHODS

The field experiment was conducted at the Research farm, Division of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir situated between 34°.05′ N latitude and 74°.89′ E longitude at an altitude of 1587 meters above mean sea level for 2 consecutive rainy (*kharif*) seasons of 2009 and 2010 Soil was silty clay loam in texture having 1.4 % coarse sand 18.2% fine sand 42.4% silt and 38% clay with *p*H 6.5, organic carbon 0.87% and available N, P, K and S 271.5, 14.3, 160 and 15.7 kg ha^{-1}, respectively. The precipitation was 177.8 and 249.9 mm during the cropping season. The experiment was laid out in factorial randomized block design, having 18 treatment combinations with three replications. The treatments comprised of three nitrogen levels *viz*. 40, 80 and 120 kg N ha^{-1}, two sulphur levels *viz*. 30 and 60 kg S ha^{-1} and three FYM treatments *viz*. 0, 10 and 20 t ha^{-1}. Well decomposed FYM as per treatment was applied to the respective plots and incorporated in the soil. Phosphorus @ 60 kg ha^{-1} and potassium @ 40 kg ha^{-1} were uniformly applied to each plot as a basal dose during both years of experimentation. Remaining half dose of nitrogen was applied in two equal splits one each at 30-35 DAS and flowering stage. Nitrogen, phosphorus, potassium and sulphur were applied through urea, di-ammonium phosphate, muriate of potash and calcium sulphate dihydrated ($CaSO_4$ $2H_2O$), respectively. After opening of furrows, the overnight soaked seed of sunflower variety of "Morden" was sown on 24 and 25 June during 2009 and 2010, respectively. The crop was thinned at 15 DAS to retain one seedling per hill at 45 cm spacing. Light irrigation was given to the crop towards ending June during both the years. Five random plants were selected in each treatment, excluding the border row, for taking observation on plant height. The leaf area index was recorded using canopy analyzer (Accu PAR Model LP-80). For dry matter representative plant samples in penultimate rows of each plot were dried in shade followed by oven drying at 60-65^{0}C to a constant weight. Observations on yield parameters were recorded from five randomly selected plants in each treatment. Crop was harvested manually on 24 and 26 September during 2009 and 2010, respectively. Yield was recorded from net plots, leaving border and penultimate rows. The oil content in seed was determined with Nuclear Magnetic Resonance Spectroscope (Ne Port Analyser Model MK III A) employing non-destructive method of oil estimation in seed. Economics was worked out using prevailing market prices of inputs and produce. Sterility percentage was calculated by the formula.

$$\text{Sterility percentage} = \frac{\text{Total number of achenes} - \text{number of filled achene}}{\text{Total number of achenes}} \times 100$$

RESULTS AND DISCUSSION

Effect on crop growth

Data (table 2) revealed significant and consistent increase in growth parameters of sunflower, *viz*. plant height, leaf area index and dry matter accumulation with the increase in nitrogen level. Growth with respect to these characters was higher with application of 120 kg N ha^{-1}, followed by 80 kg N ha^{-1}. Since nitrogen is a major constituent of chlorophyll and proteins and its adequate supply through fertilizer encouraged the photosynthesis, which results in better crop growth. Increase in growth attributes in sunflower due to nitrogen application have been reported by Shah and Khanday (2005) and Sarkar and Mallick (2009).

Application of sulphur @ 60 kg ha^{-1} recorded significant improvement in plant height, leaf area index and dry matter production over 30 kg S/ha. This could be due to role of sulphur in regulating the metabolic and enzymatic processes including photosynthesis and respiration. These results are in conformity with the findings of Poomurugesan and Poonkodi (2008).

Incorporation of farmyard manure (FYM) significantly improved growth parameters over no application. This might be due to improvement in soil physical, chemical and biological properties and increased nutrition status due to addition of organic manure. Similar findings have also been reported by Melo and De-Oliveira (1999) and Ahmad and Jabeen (2009).

Effect on yield attributes.

Yield attributes, notably capitulum diameter, achenes capitulium^{-1} and 1000-seed weight increased progressively with increase in nitrogen level up to the highest level of 120 kg ha^{-1}. This may be ascribed to the overall improvement in crop vigour and production of sufficient photosynthates owing to higher availability of nitrogen (Awasthi *et al.,* 2011). Sterility percentage also increased with the increase in nitrogen level. This could be attributed to higher number of achenes capitulum^{-1} at higher nitrogen levels, which leads to increased competition for photosynthates. Nitrogen @120 kg ha^{-1}, which remained at par with 80 kg N/ha, recorded maximum seed yield over both the years of experimentation (Table 3). This could be attributed to the positive response of agronomic characteristics associated with yield to nitrogen. Similar findings were earlier reported by Syed *et al.* (2006) and Sarkar and Mallick (2009).

Yield contributing characters were significantly influenced by sulphur application. Application of 60 kg

S ha^{-1} significantly increased the head diameter, filled achenes capitulum^{-1} and 1000-seed weight over 30 kg S ha^{-1} (Table 3). Higher photosynthesis and synthesis of proteins at higher sulphur level may have resulted in proper partitioning of photosynthates from source to sink resulting in the improvement in yield contributing characters. Seed yield increased significantly by 7.5 % with 60 kg S ha^{-1} over 30 kg S ha^{-1}. These results corroborate the findings of Ravi *et al.* (2008).

Significant improvement in yield components and seed yield was observed with application of farmyard manure, which sustained better crop growth, produced better yield attributes and ultimately higher seed yield during both the years. Increase in grain yield with 10 and 20 t ha^{-1} of farmyard manure was to the tune of 9 and 15% over no application, respectively. The above findings are in line with Manjunatha *et al.* 2009.

Effect on seed yield, oil content and oil yield

Oil content showed significant decrease with increase in the levels of nitrogen up to 120 kg ha^{-1} (Table 3). This might be attributed to increased availability of nitrogen at higher rates of nitrogen application, which resulted in greater accumulation of protein in plants and reduces availability of carbohydrates for polymerization into fatty acids, resulting in decrease in oil content in the seed. The oil yield increased significantly and consistently with increase in nitrogen levels up to 120 kg ha^{-1}. These results confirm the findings of Ozer *et al.* (2004) and Aglave *et al.* (2009).

Application of higher level of sulphur significantly increased the oil content and oil yield. Increase in oil content with 60 kg S ha^{-1} was 3% and 2.4% over 30 kg S ha^{-1} during 2009 and 2010, respectively. Oil yield increased by 13.6% and 10% with 60 kg S ha^{-1} over 30 kg S ha^{-1} during 2009 and 2010, respectively. Oil yield is a function of oil content and seed yield and both the parameters increased with higher sulphur level, thus resulting in a significant increase in oil yield. An increase in oil content and oil yield in sunflower due to sulphur application was also earlier reported by Rani *et al.* (2009). There was significant increase in oil content and oil yield with increase in FYM application. Application of FYM @ 20 t ha^{-1} remained at par with FYM @ 10 t ha^{-1}. Increase in oil yield was 10.4% and 18.6% during 2009 and 14.3% and 19% during 2010 with the application of FYM @10 and 20 t ha^{-1} over no application, respectively.

Conclusion

From the study, it is evident that application of nitrogen @ 120 kg ha^{-1}, sulphur @ 60 kg ha^{-1} and farmyard manure @10 t ha^{-1} recorded improved yield attributes, seed and oil yield of sunflower under temperate Kashmir conditions.

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Table 2: Effect of nitrogen, sulphur and FYM levels on growth characters of sunflower
(pooled over two years)

Treatment	Plant height	Leaf Area Index (LAI)	Dry matter production (DMP)
	(cm)		(q ha^{-1})
Nitrogen levels (kg ha^{-1})			
40	106.4	0.50	6.15
80	112.0	0.82	6.89
120	115.9	0.96	7.20
SE (m) ±	1.14	0.04	0.10
CD (p=0.05)	3.31	0.11	0.29
Sulphur levels (kg ha^{-1})			
30	110.24	0.68	6.59
60	112.70	0.84	7.40
SE (m) ±	0.93	0.03	0.08
CD (p=0.05)	2.7	0.09	0.24
FYM levels (t ha^{-1})			
0	108.57	0.62	6.31
10	112.50	0.82	6.91
20	113.38	0.84	7.01
SE (m) ±	1.14	0.04	0.10
CD (p=0.05)	3.31	0.11	0.29

Table 3: Effect of nitrogen, sulphur and FYM levels on yield attributes, seed yield and oil content of sunflower *(pooled over two years)*

Treatment	Capitulum diameter	Achenes capitulum^{-1}	Sterility percent	1000-seed weight	Seed yield	Oil content
	(cm)		(%)	(g)	(q ha^{-1})	(%)
Nitrogen levels (kg ha^{-1})						
40	12.42	318.4	6.38	57.6	20.2	40.90
80	12.90	356.5	6.82	59.9	24.3	39.50
120	13.20	363.3	8.15	60.0	25.5	39.00
SE (m) ±	0.07	2.27	0.39	0.46	0.49	0.36
CD (p=0.05)	0.22	6.56	1.14	1.33	1.38	1.04
Sulphur levels (kg ha^{-1})						
30	12.75	336.4	6.81	58.17	22.5	39.22
60	12.96	355.7	7.48	60.06	24.2	40.02
SE (m) ±	0.06	1.85	0.32	0.37	0.40	0.29
CD (p=0.05)	0.18	5.35	NS	1.08	1.13	0.85
FYM levels (t ha^{-1})						
0	12.56	321.4	6.06	57.71	21.6	39.00
10	12.89	352.8	6.53	59.73	23.6	40.80
20	13.11	364.0	8.83	60.08	24.9	40.74
SE (m) ±	0.07	2.27	0.39	0.46	0.49	0.36
CD (p=0.05)	0.22	6.56	1.14	1.33	1.38	NS

NS: non-significant

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