GRWOTH RESPONSE OF SUNFLOWER TO NITROGEN AND SULFUR FERTILIZATION UNDER GREEN MANURING

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Abstract- Sunflower growth and development rely on sufficient supply of macro and micro nutrients, besides other macro nutrients nitrogen and sulfur are vital for plant growth. In order to study the effect of nitrogen and sulfur on sunflower growth a two year trail was conducted. The trail was consisted of four nitrogen (0, 60, 90 and 120 kg ha^{-1}) and four sulfur (0, 15, 30 and 45 kg ha^{-1}) levels with and without green manuring of berseem crop. Growth and phenological characteristics of sunflower was studied during the trail. The results of the study indicated that days to emergence and emergence m^{-2} were not significantly affected by any of the factors studied. However, days to flower opening and maturity was significantly affected by green manuring, nitrogen and sulfur levels. Similarly leaf area and dry matter production were also significantly affected by green manuring, nitrogen and sulfur levels. Green manuring with berseem crop delayed flower opening and maturity as well as produced greater leaf area and dry matter in comparison with no green manuring. Addition of 120 kg N and 45 kg S ha^{-1} significantly delayed flower opening and maturity, moreover leaf area and dry matter production was also higher at these levels. However, higher values of the studied traits were also recorded with interactive effect of green manuring along with nitrogen at the rate of 90 kg ha^{-1}. Therefore it is concluded that application of 120 kg N alone or 90 kg with green manuring is similar for enhancing sunflower growth and sulfur application at the rate of 45 kg ha^{-1}.

Key word- Sunflower, Growth, Green Manure, Dry matter, Phenology, Nitrogen and Sulfur.

I. INTRODUCTION

Among various oil seed crop, sunflower has an important value due to its adaptability to vide range of climatic and edaphic conditions as well as its anticipated properties high production, drought tolerance, early maturity and high oil quality. It is considered an important oil seed crop of the country because its edible oil contain unsaturated fatty acids in higher ratio as compared to saturated fatty acid (Fayyaz-ul-Hasan et al., 2007).

For higher crop production and growth different macro and micro nutrients are required. Apart from other nutrients nitrogen and sulfur plays a key role in growth of oil seed crop (Shehzad et al., 2016). Most of the Pakistani soils are calcareous in nature due to which nitrogen availability is lower. Poor growth and reduced cell development is triggered due to the deficiency of nitrogen (Rasheed et al., 2004). Certain metabolic processes that are responsible for higher growth and production are totally dependent on nitrogen and deficiency cause reduction in growth characters (Du et al., 2015). Nitrogen is very essential for plant growth and performance (Suo and Wang, 2000) as it plays key role in leaf expansion and leaf area development which lead to higher photosynthetic activity.

Availability of different nutrients is the main factor that controls the sunflower yield (Habib et al., 2006). Fertilizer application boosts the fertility status of soil; enhance the nutrients uptake by the plant that finally increase crop yield (Adediranet al., 2004). However in intensive agriculture, nitrogen is the major nutrient determining sunflower yield (Abdel-Motagally and Osman, 2010).

The imbalance in composite usage, principally of Sulfur (S) has been a concern in Pakistan as it could impact the financial development and general rural efficiency (FAO, 2008).It has also been highlighted in various findings that almost 90% of Pakistan soils are deficient in sulfur content (Shaheen *et al.*, 2011). Sulfur (S) is considered as the fourth most important essential element after N, P and K for crop production (Tandon and messick, 2002) and is actively involved in plant growth, seed yield, oil and protein synthesis as well as improved quality of produce owing to its role in enzymatic and metabolic processes (Roche et al.,2004; Hussain et al., 2011). Sulfur helps in the synthesis of cysteine, methionine, chlorophyll, vitamins (B, biotin and thiamine) (Wani et al., 2001), 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). This study was aimed to find out best nutrients combination for higher growth of sunflower.

II. MATERIALS AND METHODS

A two year experiment was conducted at Agronomy Research Farm of the University of Agriculture Peshawar. The experiment was established using randomized complete block design with 3 replications. Sunflower hybrid 'HySun 33' was sown in February, 2019. Experiment was consisted of three factors including green manuring, nitrogen and sulfur levels. The green manuring was consisted of two level (no GM and GM with berseem). Different levels of nitrogen include 0, 60, 90 and 120 kg N ha^{-1}, while sulfur levels was 0, 15, 30 and 45 kg S ha^{-1}. Nitrogen was applied in the form of urea in two splits i.e. 50% at sowing and 50% with second irrigation (30 DAS). All Sulfur in the form of 'kumulus DF', a product of FMC company contains 80 % sulfur by weight was applied at time of sowing. Recommended dose of phosphorus and potassium was applied at the rate of 60 kg ha^{-1} at sowing in the form of Single Super Phosphate(SSP) and Murate of Potash(MOP), respectively.

Observations

Data were recorded on days to emergence, emergence m^{-2}, leaf area, number of leaves, days to flower opening, days to maturity and dry matter production.

Statistical analysis

For analysis of the obtained data in accordance with RCBD split plot arrangement, the computer software Statistix 8.1 was used. Further, means and their differences were separated by applying Least significant difference (LSD) test (Steel and Torrie, 1980).

III. RESULTS

A. *Days to emergence and emergence m^{-2}*

Days to emergence and emergence m^{-2} of sunflower as affected by green manuring, nitrogen and sulfur levels are shown in Table 1. Statistical analysis of the data indicated that all the factors tested i.e. green manuring, nitrogen and sulfur levels had no considerable effect on days to emergence as well as emergence m^{-2} of sunflower. Similarly all the interactions were found non-significant.

Table 1. Days to emergence and emergence m^{-2} of sunflower in response to green manuring, nitrogen and sulfur levels.

Green manure	Days to emergence	Emergence m^{-2}
No green manure	9.4	8.4
Berseem	9.4	8.4
Significance	NS	NS
Nitrogen (N) (kg ha^{-1})		
0	9.3	8.5
60	9.5	8.3
90	9.3	8.3
120	9.6	8.4
LSD (0.05)	NS	NS
Sulphur (S) (kg ha^{-1})		
0	9.5	8.5
15	9.2	8.4
30	9.6	8.4
45	9.3	8.3
LSD (0.05)	NS	NS

B. *Number of leaf plant^{-1}*

Number of leaves plant^{-1} as affected by different green manuring, nitrogen and sulfur levels is shown in Table 2. The effect of green manuring, nitrogen and sulfur levels was not significant on number of leaves plant^{-1} of sunflower. Likewise, all the possible interactions were not significant for number of leaves plant^{-1}. Moreover, variation across the years were also not significant.

C. *Days to flower opening*

The effect of green manuring, nitrogen and sulfur on days to flower opening of sunflower is presented in Table 2. Statistical analysis of the data indicated that green manuring, nitrogen and sulfur considerably varied days to flower opening of sunflower. All the possible interactions were not significant for days to flower opening. Mean values of the data regarding year revealed that flowering was delayed in 2020 as compared to 2019. In case of green manuring, green manuring with berseem crop delayed flowering in sunflower as compared to no green manuring. Among different levels of nitrogen, increasing nitrogen levels from 0 to 120 kg ha^{-1} significantly delayed flower opening in sunflower and vice versa. Maximum days to flowering was recorded with addition of 120 kg nitrogen ha^{-1}, while minimum days to flower opening in sunflower was observed with no nitrogen application. Among various sulfur levels, application of sulfur at the rate of 30 kg ha^{-1} took more days to flower opening, which was statistically similar with days to flower opening recorded with addition of 45 kg sulfur ha^{-1}. Control plots with no sulfur application took less days to flower opening.

Table 2. Number of leaves plant^{-1} and days to flowering of sunflower in response to green manuring, nitrogen and sulfur levels.

Green manure	Number of leaves	Days to flower opening
No green manure	24	64
Berseem	24	66
Significance	NS	**
Nitrogen (N) (kg ha^{-1})		
0	23	63
60	24	64
90	23	65
120	24	67
LSD (0.05)	NS	1
Sulphur (S) (kg ha^{-1})		
0	24	64
15	24	64
30	24	66

45	23	66
LSD (0.05)	NS	1

D. Leaf area plant^{-1}

Leaf area plant^{-1} of sunflower as influenced by different green manuring (GM), nitrogen (N) and sulfur (S) levels is given in Table 3. Statistical analysis of the data revealed that green manuring, nitrogen and sulfur level significantly affected leaf area of sunflower. The interactions between GM x N and GM x N x S were found significant, while the rest of interactions were not significant. Significant variations in leaf area of sunflower were observed during two years. Greater leaf area plant^{-1} was produced in 2020 as compared to 2019. Mean values regarding green manuring revealed more leaf areaplant^{-1} with green manuring as compared to no green manuring. Among different levels of nitrogen, increasing nitrogen levels increased leaf area of sunflower. Application of 90 and 120 kg N ha^{-1} produced higher leaf area plant^{-1}, which were statistically at par with each other. Controlled plots produced lower leaf area plant^{-1} in sunflower. Addition of sulfur at the rate of 45 kg ha^{-1} produced greater leaf area plant^{-1}, which was statistically similar with leaf areaplant^{-1} recorded with 30 kg sulfur ha^{-1}. Minimum leaf area plant^{-1} was noted in plots treated with no sulfur. The interaction between GM x N indicated that increasing nitrogen level from 0 to 90 kg ha^{-1} increased leaf area plant^{-1} regardless of green manuring, however further increasing N level beyond 90 kg ha^{-1} increased leaf area plant^{-1} without green manuring. Leaf area plant^{-1} did not increase with increasing nitrogen beyond 90 kg ha^{-1} along with green manuring (Fig. 1). The interaction between GM x N x S revealed that increasing nitrogen level from 0 to 90 kg ha^{-1} increased leaf area with increase in S levels regardless of green manuring and further increasing nitrogen level with 30 and 45 kg S increased leaf area with or without GM and decrease leaf area at 0 and 15 kg S (Fig. 2).

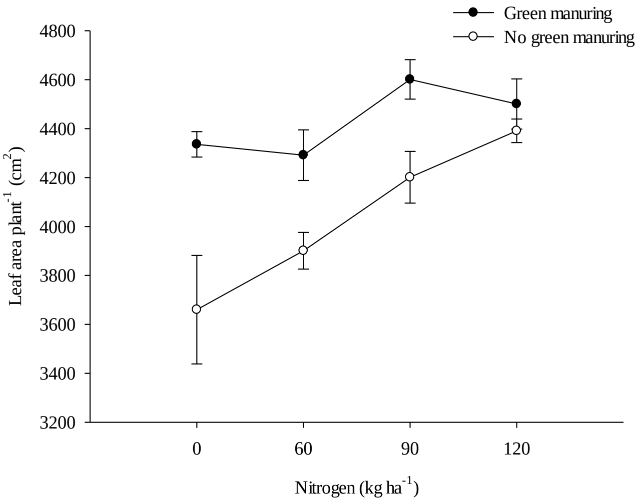

Figure 1. GM x N interaction for leaf area plant^{-1} of sunflower

E. Days to maturity

Days to maturity of sunflower as affected by different green manuring, nitrogen and sulfur levels is shown in Table 3. Statistical analysis of the data showed that green manuring, nitrogen and sulfur levels considerably varied days to maturity of sunflower. All the possible interactions were not significant for days to maturity. Maturity was considerably different across the years. Mean values of the data regarding year revealed that maturity was delayed in 2020 as compared to 2019. In case of green manuring, green manuring with berseem crop delayed maturity in sunflower as compared to no green manuring. Among different levels of nitrogen, application of nitrogen increased days to maturity and late maturity was observed with 90 kg N ha^{-1}, which was statistically at par with application of 120 kg N ha^{-1}. Early maturity was observed with no N application. Among various sulfur levels, application of sulfur at the rate of 45 kg ha^{-1} took more days to maturity. Control plots with no sulfur application took less days to maturity.

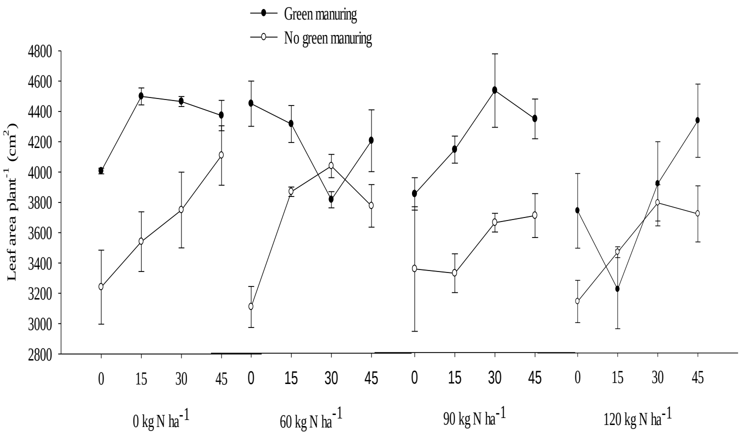

Figure 2. GM x N x S interaction for leaf area plant^{-1} of sunflower

F. Dry matter production

Total dry matter at maturity stage as influenced by green manuring, nitrogen and sulfur levels is shown in Table 3. Statistical perusal of the data indicated that green manuring, nitrogen and sulfur had profound effect on total dry matter production at maturity. The interaction between green manuring and nitrogen levels (GM x N) was the only significant interaction for total dry matter production at maturity, while the rest of the interactions were insignificant. Year as source of variation significantly varied dry matter production at maturity of sunflower. Total dry matter produced was higher in 2020 than 2019. Green manuring increased dry matter production at maturity as compared to no green manuring. Mean values of the data concerning nitrogen levels revealed that increasing nitrogen levels linearly increased dry matter production at maturity. Higher dry matter at maturity was recorded with 120 kg N ha^{-1}, which was followed by 90 kg ha^{-1}. Minimum dry matter at maturity was observed with no N application. Among various sulfur levels, sulfur application increased dry matter production at maturity. Higher dry matter at maturity was produced with addition of 45 kg S ha^{-1}, which was followed by 30 kg S ha^{-1}. Lower dry matter at maturity was produced with no sulfur application. The interaction between GM x N shown that increasing nitrogen level increased dry matter production at maturity regardless of green manuring, however the increased was more prominent with increasing nitrogen along with green manuring (Fig. 3).

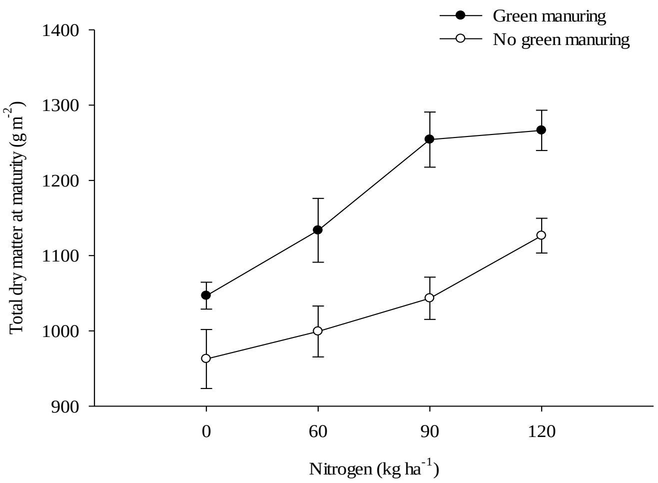

Figure 3. GM x N interaction for total dry matter

Table 3. leaf area, days to maturity and dry matter production of sunflower in response of green manuring, nitrogen and sulfur levels.

Green manure	Leaf area (cm^2)	Days to maturity	Dry matter ($g\ m^{-2}$)
No green manure	4038	98	895
Berseem	4432	100	1002
Significance	**	**	**
Nitrogen (N) ($kg\ ha^{-1}$)			
0	3998	97	874
60	4096	99	918
90	4401	100	978
120	4446	100	1025
LSD (0.05)	146	1	**28**
Sulphur (S) ($kg\ ha^{-1}$)			
0	4049	98	880
15	4219	99	925
30	4311	99	974
45	4363	100	1015
LSD (0.05)	146	1	**28**

IV. DISCUSSIONS

There was no considerable effect of different factors tested on days to emergence and emergence m^{-2} of sunflower. There was no statistical difference in emergence which might be due to the fact that at germination stage all the nutrients are stored in seed. There is no effect of nutrients applied from external sources. Moreover, soil conditions and physical properties effect the emergence process, therefore nutrients had no effect on this trait of the crop. Crop phenology like days to flowering and maturity was considerably varied by green manuring, nitrogen and sulfur levels. Green manuring delayed flowering and maturity as compared to no green manuring because it provided nutrients like nitrogen and improve vegetative growth. Nitrogen application delayed flowering and maturity of sunflower. Nitrogen application at higher rates delay flowering because of more metabolites consumption by vegetative parts of plants. Higher level of nitrogen delayed flowering due to sufficient vegetative growth (Oyinlola et al., 2010). Similar results were early reported by Prasad et al. (2002), Mujiri and Arzani (2003) and Sadras (2006) who reported that increase in vegetative growth increased number of days to different stages. Sadiq et al. (2000) reported that by increasing nitrogen level number of days were delayed from flowering to maturity. Increasing sulfur application delayed flowering and maturity in sunflower. Which might be due to the fact that sulfur increase nutrient uptake especially nitrogen, thus enhancing vegetative growth. Similar results were earlier reported by Rehman et al. (2013) who reported delayed flowering and maturity with sulfur application.

Leaf area was considerably affected by green manuring, nitrogen and sulfur levels. Green manuring of berseem increased leaf area as compared to no green manuring. Green manuring is one of the practice to improve soil fertility and productivity by incorporating nutrients like N. The increase in leaf area with green manuring of berseem crop might be due to the nutrients availability especially nitrogen. Moreover leguminous crop fixed atmospheric nitrogen which improved plant growth. Hemalatha et al. (2000) reported that incorporation of leguminous crop at 12 tons ha^{-1} increase plant height and leaf area in rice.

Green manuring significantly improved dry matter accumulation. The improvement in dry matter production with green manuring might be due to the ability of green manures to provide sufficient nutrients to the plants and improve soil properties. Baiyeri and Tenkouano (2007) reported similar trend and stated that green manuring enhanced properties of soil and soil fertility which lead to improvement in photosynthetic efficiency and assimilates partitioning. Moreover, Ayeni and Adetunji (2010) also stated that green manuring supply essential nutrients to crop which enhanced the dry matter production that resulted in maximum dry matter production. Application of green manuring together with nitrogen fertilizer will balance carbon and nitrogen in soil and plants can uptake nitrogen requirement and other nutrients from soil (Mosavi et al., 2009).

Nitrogen application improve dry matter production. The probable reason for improvement in dry matter production with application of nitrogen is the ability of nitrogen to increase light interception, photosynthetic efficiency and transfer of assimilates (Shekhawat and Shivay, 2012). In contrast poor nitrogen availability to plants resulted in reduced photosynthetic ability, and decrease in assimilates production which leads to lower crop growth and dry matter production (Osterhuis and Zhao, 2006). These results are in line with those reported by Dordas and Siolas (2009) who reported higher crop growth rate, photosynthates and dry matter with increasing level of nitrogen rates.

Sulfur levels significantly varied dry matter production. Increasing sulfur levels increased dry matter production. Which could be attributed to boost photosynthesis accumulation. Sulfur is constituent of enzymes which is involved in chlorophyll production and activating cellular level of accelerated photosynthesis (Deepika et al., 2022). Thus resulting in more dry matter accumulation. These results are similar to those reported by Ramu and Reddy (2003) and Sarkar and Mallick (2009) who reported increased dry matter with application of sulfur.

Similarly nitrogen application increased leaf area, increasing nitrogen levels linearly increased leaf area. Nitrogen is the key element which enhanced vegetative growth and is the main constituent of plant body thus increasing cell development and improving crop growth (Al-thabet, 2006). Our results are in harmony with findings of Abelardo and Hall (2002) who stated that combine application of sulfur and nitrogen improve plant height and leaf area of plant. Which might be due to the nutrient uptake and sulfur role in metabolism. Ramu and Reddy (2003) reported similar results that plant height and leaf area was significantly increased with addition of nitrogen and sulfur. Similar positive responses of S on plant growth parameters were earlier reported by Ozer et al. (2004). Similarly Rehman et al. (2013) concluded that sulfur application considerably increased leaf area and leaf area index.

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