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INFLUENCE OF SEASONAL DISPARITY ON NPK UPTAKE IN SUNFLOWER

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ABSTRACT

Crop-environment interaction is a key factor in the assessment of crop performance, thus nutrients uptake by crop plants require coincidence of vegetative and reproductive stages with suitable environmental conditions. The influence of seasonal variation on NPK uptake in sunflower was studied through field experiments executed at Pir Mehr Ali Shah, Arid Agriculture University Rawalpindi, Pakistan for two years (2007 & 08) during spring and autumn. Four Sunflower hybrids, Alisson-RM, Parasio-24, MG-2 and S-278 were planted in Randomized Complete Block Design with four replications using seed rate of 5 kg $ha^{-1.}$ The data on nitrogen, phosphorus and potassium uptake by plants was recorded at physiological maturity. NKP uptake was significantly influenced by prevailing season. Overall, spring planted crop exhibited significantly higher values for NPK uptake at physiological maturity than during autumn which may be attributed to the longer crop life span facilitating nutrient uptake. However, shorter crop life cycle of autumn planted crop limited uptake. Amongst hybrids, MG-2 took up the maximum quantities of NPK during both the seasons (spring & autumn) probably due to higher yield potential. It may be concluded that farmers planting autumn sunflower should reduce NPK inputs as output would be strongly influenced by shorter growing season.

Key words: Seasonal variation; NPK uptake; Sunflower; crop life cycle

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is an important oilseed crop suited to agro-climatic conditions and prevailing cropping systems of Pakistan (Kaleem *et al.*, 2011). It requires a warm climate with moderate rainfall and shows wide range of tolerance to wet and dry conditions.

Sunflower responds relatively better to management factors. The adequate and balanced supply of plant nutrients is of critical importance to improve productivity of oilseeds. Nutrient removal by crops far exceeds than the nutrient additions through fertilizer (Bharose *et al*., 2011). Nitrogen, phosphorus and potassium are the major plant nutrients essential for crop growth and development. Excess or deficiency of any one of these nutrients can cause excessive or stunted growth, leaving plants vulnerable to attack from various diseases and pests (Bakht *et al.*, 2010). Nitrogen is the most important nutrient, which determines the growth of the oilseed crops and increases the amount of protein and the yield. Phosphorus and potash are known to be efficiently utilized in the presence of nitrogen. It promotes flowering, setting of seeds and increases the yield in oilseed crops (Bharose *et al*., 2011).

Biomass accumulation in sunflower is correlated with nutrient uptake throughout its life span (Malik *et al.*, 2004). Sunflower is a well-adapted drought tolerant crop, essentially because of the better water and nutrients uptake due to its efficient root system (Esmaeilian *et al*., 2011). The growing conditions as well as season had significant effect on physio-morphic as well as nutrient uptake features through out the crop growth period (Nasim *et al.*, 2011). Fertilizer recovery is the result of the balance between crop N uptake and N immobilization by microbial processes in soils of different compositions. Therefore, the concept of the nitrogen use efficiency (NUE) of a crop should also be considered as a function of soil texture, climatic conditions, interactions between soil and bacterial processes (Burger and Jackson, 2004). The content and uptake of these nutrients depend not only on their availability in the soil but also on distribution pattern of plants on a particular piece of land, the growth stage and environmental factors (Hassan and Leitch, 2000).

Direct application of chemical fertilizers to the sunflower crop stimulated N, P and K uptake and the highest nutrient uptake values were noted for the 100% recommended dose of fertilizer treatment (Mahavishnan *et al.*, 2005). Understanding N fluxes, its uptake and distribution in the plant is of prime importance with respect to both environmental concerns and product quality. Uptake and N utilization in crops are two major components of the N cycle (Rehman *et al.*, 2011). Oilseed crops have higher capacity to take up nitrate from the soil and thus to accumulate large quantities of N that is stored in vegetative parts at the beginning of flowering (Hocking and Strapper, 2001).

Variations found in the uptake of N, P and K could be due to variation in weather conditions and the total length of the growth period (Hassan and Leitch, 2000) as climatic variability is a major cause of reduced agricultural productivity and inability of agricultural crops to achieve potential yield (Agele, 2003). Seasonal variation significantly affected different crop attributes in sunflower (Kaleem *et al.*, 2009) thus, presumably NPK uptake would vary. Ahmad *et al.* (2009) reported higher NPK uptake in wheat as a result of higher seasonal rainfall.

The present study has been therefore, undertaken to determine the effect of varying seasons on the NPK uptake of sunflower and to record crop-environment interaction under sub humid conditions of Pothwar.

MATERIALS AND METHODS

The influence of seasonal variation on NPK uptake in sunflower was studied through field experiments executed at Pir Mehr Ali Shah, Arid Agriculture University Rawalpindi, Pakistan located at 33^o and 38^o N and 73^o and 04^o E, during 2007 and 2008 (spring and autumn in each year). The soil of experimental site was loam type in texture having sand 43%, silt 46% and clay 11%, pH 7.4 and EC 0.66 m S cm^{-1}. Available NPK status in the soil before sowing was 300, 5.00 and 140 mg kg^{-1}, respectively. The particular experimental site was winter fallow prepared for sowing by giving one soil inverting plough, thereafter, ploughed thrice with tractor mounted cultivator and planked with last ploughing. Recommended dose of fertilizer of 80 kg Nitrogen and 60 kg P_2O_5 per hectare was applied in the form of Urea and DAP at the time of last ploughing. Spring crop was sown on 18^{th} March for each year while autumn crop was sown on 18^{th} August for each year. Four sunflower hybrids (Alisson-RM, Parasio-24, MG-2 and S-278 were sown in randomized complete block design replicated four times by using seed @ 5 kg/ha. Seeds were sown with dibbler by putting two seeds at each pre-marked spot. Plant to plant distance was maintained 25 cm and row to row 75 cm in net plot size of 5x3 m^2. After complete emergence, one plant was maintained per hill. Weeds were kept under control by hand weeding through out crop life cycle. Weather data for the growth period of crop during two years, 2007 and 2008 was collected from the Pakistan Meteorological Department, National Agromet Observatory located near the experimental site (Table 1).

Nitrogen concentration (%)/ off take in plants (kg/ha): To work out nitrogen concentration/off take by plants, plants from one meter row length of central row were removed from soil level from each experimental unit at physiological maturity. These plants were cleaned, cut and oven dried for 24 hours at 70^oC. Separate fractions of stem, leaves and inflorescence were collected, grinded and stored in air tight plastic storage bottles. The nitrogen concentration was determined by using micro Kjeldahl method (Nelson and Sommers, 1980). N off take was worked out by multiplying N concentration with dry matter produced per unit area.

Phosphorus and Potassium concentration (%) / off take in plants (kg/ha): The representative ground plant samples were used for the determination of phosphorus and potassium concentration. Plant samples were dry ashed, then diluted in 50 ml distilled water and filtered through filter paper Watman No. 42. Phosphorus concentration was determined by recording the absorbance at 660 nm on spectrophotometer while K concentration in plant was determined by flame photometer (PEP 7C, Jenway UK) (Issac and Johnson, 1975). Phosphorus and potassium off take was worked out by multiplying P and K percentage with dry matter produced per unit area.

Statistical Analysis: The collected data were subjected to statistical analysis by applying MSTATC, separately for both the years (Freed and Eisensmith, 1986). Analysis of Variance Techniques were employed to test the significance of data. Least Significant Difference Test at 5% probability was used to compare the means **(**Montgomery**,** 2001).

RESULTS AND DISCUSSION

Nitrogen Uptake (kg ha^{-1}): The hybrids differed significantly for N uptake during spring season (Table 2). Maximum (426.09 kg ha^{-1}) nitrogen uptake was recorded for hybrid MG-2 which was statistically ($p < 0.05$) different from the rest of the hybrids while, Parasio-24 showed the minimum (242.63 kg ha^{-1}) uptake. During autumn, differences among hybrids for nitrogen uptake also varied statistically. Nitrogen uptake during autumn exhibited similar trend as in spring, however, significance level narrowed down. Nitrogen uptake by the plants may be influenced by soil nutrients, availability of nutrients and growing conditions. It is evident from the results that nitrogen uptake by all the hybrids decreased during autumn as compared to those observed during spring. This was probably due to longer crop growth period in spring with higher dry matter production thus facilitating higher nitrogen uptake than lower during autumn. Significant relationship (Fig. 1) between dry matter yield and N uptake is also supportive to this assumption. These results are in conformity with those of Hassan and Leitch (2000) who concluded that crop for longer growth period in the field, assimilated relatively higher nutrients than that which remained for shorter period of time in the field. Similarly, Kapila *et al.* (2008) revealed that the application of various nutrient treatments significantly enhanced the total uptake of N, P, K, S and B in spring sunflower.

The interaction of hybrids x years were statistically significant for both the seasons. The maximum (442.58, 282.06 kg ha^{-1}) nitrogen uptake was recorded from the hybrid MG-2 during spring 2007 and autumn 2008, respectively, while the minimum (235.62, 89.59 kg ha^{-1}) was observed from Parasio-24 during spring 2007 and autumn 2007, respectively. Comparison of years showed statistical differences during the both, spring and autumn seasons (Table 2). These results are in accordance with those of Abbasi *et al.* (2005) who concluded that N utilization and uptake is generally affected by growing conditions and crop species. Similarly, Rehman *et al*. (2011) reported better efficiency of applied nutrients (FUE and NUE) possibly due to better growing conditions. Nitrogen exhibited significant positive correlation with weather parameters (Table 5) during spring except for rainfall which showed significant negative correlation while, showed significant negative correlation during autumn except for GDD.

Phosphorus Uptake (kg ha^{-1}): Phosphorus uptake by the plants may be influenced by soil nutrients, availability of nutrients and growing conditions. The hybrids differed significantly for phosphorus uptake during spring season (Table 3). Maximum (56.84 kg ha^{-1}) phosphorus uptake was recorded by hybrid MG-2 which was statistically ($p< 0.05$) different from the rest of the hybrids, while Parasio-24 showed the minimum (31.02 kg ha^{-1}) uptake. During autumn, differences among hybrids for phosphorus uptake were also statistically significant. Phosphorus uptake during autumn exhibited similar trend as in spring, however, significance level narrowed. It is evident from the results that phosphorus uptake by all the hybrids decreased during autumn as compared to those observed during spring. This was probably due to longer crop growth period in spring with maximum dry matter production. These results are in conformity with those of Agele (2003) who found that different seasons influenced phenology, growth, nutrients uptake and biomass production in sunflower.

The interaction of hybrids x years were statistically significant for both the seasons. The maximum (61.96, 27.21 kg ha^{-1}) phosphorus uptake was recorded from the hybrid MG-2 during spring 2007 and autumn 2007, respectively, while the minimum (31.02, 8.19 kg ha^{-1}) was observed from Parasio-24 during spring 2008 and autumn 2007, respectively. Comparison of years showed statistical differences during the both, spring and autumn seasons (Table 3).

Higher P uptake during spring compared with lower during autumn is supported by the findings of Mmolawa and Or (2000) who concluded that the difference in P uptake between the two environments might be the effect of total dry matter production and temperature. Similarly, Ahmad *et al.* (2009) also found variation in nutrients uptake due to difference in growing conditions. Linear relationship (Fig. 2) between dry matter yield and P uptake during both the seasons i.e. spring and autumn is also supportive to above findings. Phosphorus exhibited significant positive correlation with weather parameters (Table 5) during spring except for rainfall which showed significant negative correlation. Similarly, Phosphorus exhibited non significant negative correlation with GDD (Table 5) during autumn while, significant negative correlation with sunshine hours and rainfall**.**

Potassium Uptake (kg ha^{-1}): Potassium uptake by the plants may be influenced by soil nutrients, availability of nutrients and growing conditions. The hybrids differed significantly for potassium uptake during spring season (Table 4). The maximum (440.22 kg ha^{-1}) potassium uptake was recorded from hybrid MG-2 which was statistically ($p< 0.05$) different from the rest of the hybrids while, Parasio-24 showed the minimum (288.41 kg ha^{-1}) uptake. During autumn, differences among hybrids for potassium uptake were also statistically significant. Potassium uptake during autumn exhibited similar trend as in spring, however, significance level was narrow. It is evident from the results that potassium uptake from all the hybrids decreased during autumn as compared to those observed during spring. Our results are in conformity with the findings of Ahmad *et al.* (2009) who found variation in nutrients uptake probably due to crop life cycle and prevailing growing conditions.

The interaction (hybrids x years) were statistically significant for both the seasons. The maximum (475.03, 265.1 kg ha^{-1}) potassium uptake was recorded from hybrid MG-2 during spring 2007 and autumn 2008, respectively, while the minimum (273.1, 92.87 kg ha^{-1}) was observed from Parasio-24 during spring 2007 and autumn 2007, respectively. Comparison of years showed statistical differences during both, spring and autumn seasons (Table 4). These results are in accordance with those of Mmolawa and Or (2000) who concluded that nutrients uptake considerably varied with growing season. Similar results were also reported by Agele (2003) who found influence of weather on phenology, growth, nutrients uptake, biomass production and seed yield in sunflower.

Higher potassium uptake during spring compared with lower during autumn is supported by the findings of Kumaresan *et al*., (2003) and Hassan and Leitch (2000) who concluded that variations found in NPK concentrations and uptake could be due to variations in weather conditions and total length of growth period. Significant relationship (Fig. 3) between dry matter yield and K uptake is supportive to above findings. Potassium showed non significant positive correlation with weather parameters except for rainfall which showed significant negative correlation during spring (Table 5). Similarly, Potassium exhibited non significant negative correlation with GDD and sunshine hours (Table 5) during autumn but significant negative correlation with rainfall.

Table 1: Meteorological data of two years, Spring 2007, 2008 and Autumn 2007,2008.

	SPRING 2007				SPRING 2008			
MONTH	Temperature (°C)		Rain fall (mm)	Sunshine (Hours) (Mean)	Temperature (°C)		Rainfall (mm)	Sunshine (Hours) (Mean)
	Max (Mean)	Min. (Mean)			Max. (Mean)	Min. (Mean)		
March	23.10	9.00	143.20	7.40	29.67	11.78	19.10	7.90
April	34.00	15.90	18.00	10.70	29.70	15.77	92.90	7.71
May	37.30	19.80	80.60	10.00	37.16	20.76	10.10	9.92
June	37.60	23.00	22.30	9.50	35.57	22.29	225.00	7.47
July	35.20	21.50	262.50	9.30	35.01	22.75	432.50	7.38
	AUTUMN 2007				**AUTUMN 2008**			
August	34.20	21.80	485.00	8.30	33.32	22.97	221.00	7.46
September	32.90	19.40	201.00	7.80	32.28	19.67	66.00	8.14
October	31.50	12.60	0.00	9.60	31.03	15.37	24.00	7.88
November	26.00	8.20	10.00	7.00	25.24	8.13	18.00	8.53
December	-	-	-	-	20.77	5.49	71.70	6.44

Table 2. Nitrogen uptake (kg ha^{-1}) of sunflower hybrids at physiological maturity during two seasons of 2007 and 2008

	Seasons					
	Spring			**Autumn**		
	Years			**Years**		
Hybrids	**2007**	**2008**	**Mean**	**2007**	**2008**	**Mean**
Alisson-RM	324.36 e	319.54 f	**321.95 C**	118.93 g	211.25 d	**165.09 C**
Parasio-24	235.62 h	249.65 g	**242.63 D**	89.59 h	124.44 f	**107.01 D**
MG-2	442.58 a	409.61 b	**426.09 A**	229.39 b	282.06 a	**255.72 A**
S- 278	385.49 c	348.73 d	**367.11 B**	145.18 e	217.03 c	**181.10 B**
Mean	**347.01 A**	**331.88 B**		**145.77 B**	**208.69 A**	

*Any two means not sharing a letter common in a row or column differ significantly at 5% probability level

Table 3. Phosphorus uptake (kg ha^{-1}) of sunflower hybrids at physiological maturity during two seasons of 2007 and 2008

	Seasons					
	Spring			**Autumn**		
	Years			**Years**		
Hybrids	**2007**	**2008**	**Mean**	**2007**	**2008**	**Mean**
Alisson- RM	43.24 d	36.65 e	**40.94 C**	14.02 e	23.88 c	**18.95 C**
Parasio-24	32.13 f	29.91 g	**31.02 D**	8.19 g	11.82 f	**10.00 D**
MG-2	61.96 a	51.72 c	**56.84 A**	27.21 b	33.93 a	**30.57 A**
S- 278	55.27 b	39.03 e	**47.15 B**	17.66 d	26.90 b	**22.28 B**
Mean	**48.15 A**	**39.82 B**		**16.77 B**	**24.13 A**	

*Any two means not sharing a letter common in a row or column differ significantly at 5% probability level

Table 4. Potassium uptake (kg ha^{-1}) of sunflower hybrids at physiological maturity during two seasons of 2007 and 2008

Seasons						
	Spring			Autumn		
	Years			Years		
Hybrids	2007	2008	Mean	2007	2008	Mean
Alisson-RM	345.98 e	340.16 f	**343.07 C**	118.32 f	203.90 c	**161.11 C**
Parasio-24	273.10 h	303.73 g	**288.41 D**	92.87 g	126.92 e	**109.89 D**
MG-2	475.03 a	405.42 c	**440.22 A**	212.86 b	265.10 a	**238.98 A**
S- 278	425.17 b	356.54 d	**390.85 B**	130.80 d	214.25 b	**172.52 B**
Mean	**379.82 A**	**351.46 B**		**138.71 B**	**202.54 A**	

*Any two means not sharing a letter common in a row or column differ significantly at 5% probability level

Table 5. Correlation among weather parameters, Nitrogen, Phosphorus and Potassium uptake by sunflower during the both, spring and autumn seasons

S #	Weather parameters	Spring			Autumn		
	Plant parameters	Nitrogen uptake	Phosphorus uptake	Potassium uptake	Nitrogen uptake	Phosphorus uptake	Potassium uptake
1	**Growing Degree Days**	0.52	0.52	0.46	- 0.20	- 0.11	- 0.22
2	**Sunshine Hours**	0.54	0.52	0.46	- 0.63	-0.58	- 0.46
3	**Rainfall**	- 0.55	- 0.60	- 0.61	- 0.99	- 0.99	- 0.99

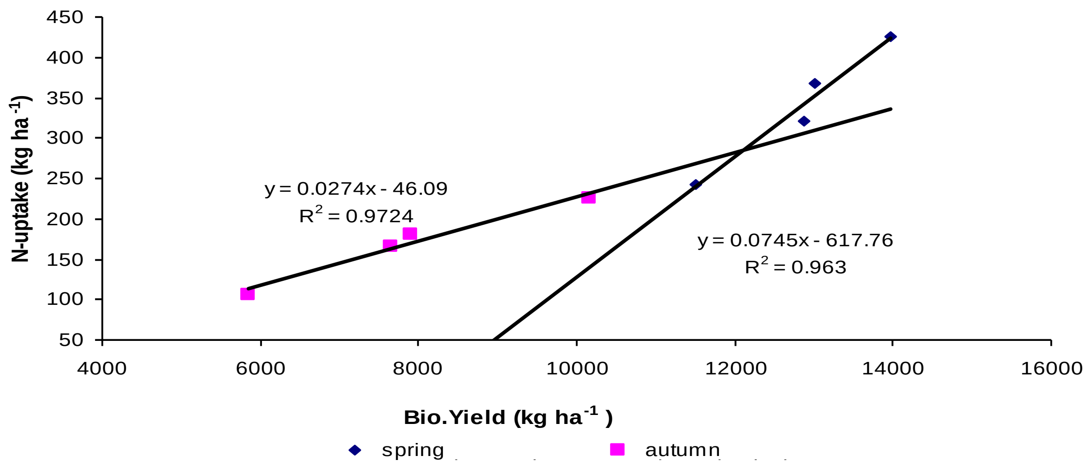

Fig. 1. Relationship between biological yield and nitrogen (N) uptake during spring and autumn seasons

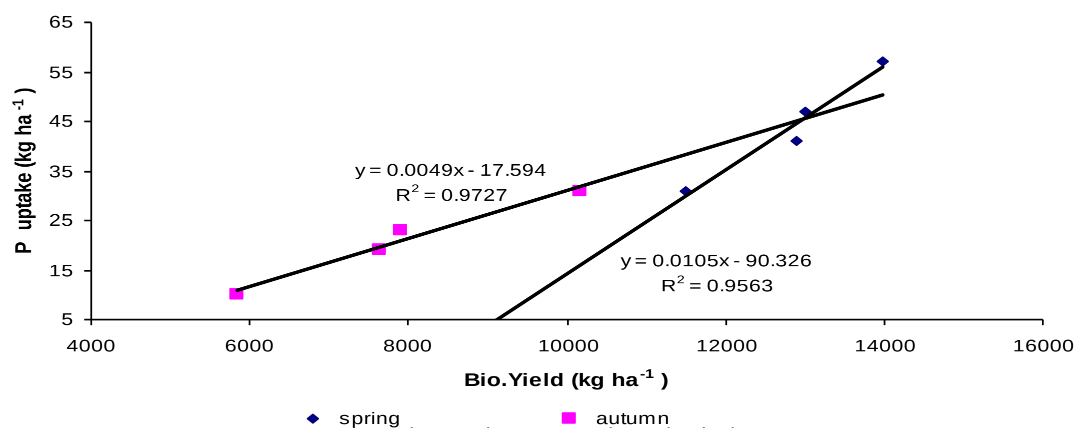

Fig. 2. Relationship between biological yield and phosphorus (P) uptake during spring and autumn seasons

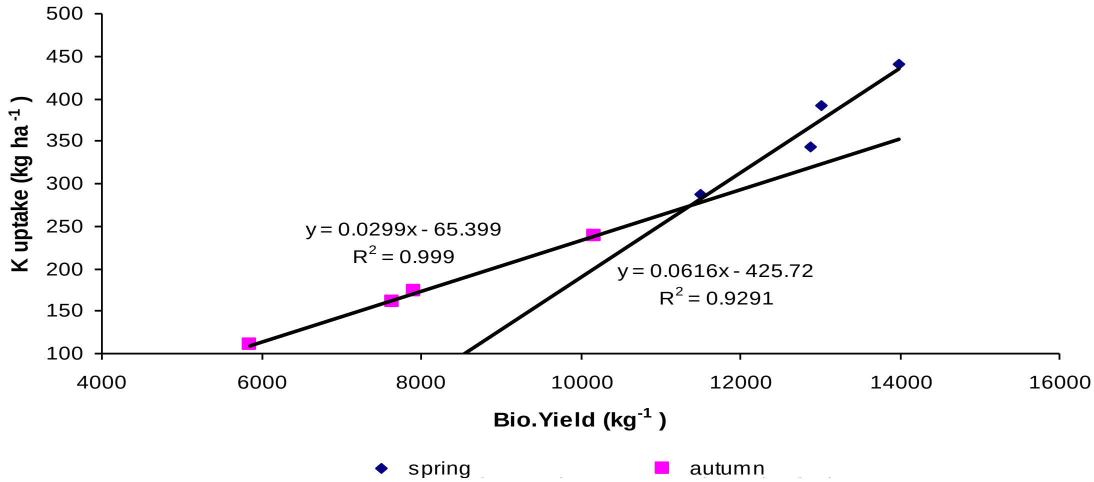

Fig. 3. Relationship between biological yield and potassium (K) uptake during spring and autumn seasons

Conclusion : It may be concluded from present results that economically successful sunflower crop should be planted during spring for maximum achene and oil yield. However, autumn crop can be sown as an alternate crop with half of recommended inputs.

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