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International Journal of Current Research
Vol. 8, Issue, 02, pp.26515-26518, February, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

BIOLOGICAL AND AGRONOMIC YIELD AS A FUNCTION OF POTASSIUM AND VASE LIFE OF SUNFLOWER (*Helianthus annuus* L.) (ASTERACEAE)

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ARTICLE INFO

Article History:
Received 27th November, 2015
Received in revised form
13th December, 2015
Accepted 21st January, 2016
Published online 27th February, 2016

Key words:
Biomass, Agronomic yield,
Biological yield, Vase life.

ABSTRACT

With the objective of known to the effect of application of potassium on theagronomic yield and biological and postharvest of inflorescences of sunflower, two experiments was carried, one under field conditions and another at laboratory. In laboratory, the variables was evaluated under randomized block design where at treatments was four levels of fertilization: 0, 50, 100 y 150 kg ha^{-1} of K_2O. In laboratory, the variables vase life, diameter of chapter, percentage of mature tubular flowers and water consumed, was evaluated under a design completely randomized. The results indicated that the application of 100 and 150 kg ha^{-1} of potassium increased the agronomic yield, biological, vase life and diameter of chapter. In this work it was concluded, that the potassium applied in the crop of sunflower affected positively.

Citation: **Juan Manuel Loeza-Corte, Ernesto Díaz-López, Alejandro-Morales-Ruíz, Edgar Josanine Vargas-Ramírez, Arturo Olivar-Hernández, Rodolfo Clemente Reséndíz-Melgar and Erika Teresa Díaz-Oreján, 2016.** "Biological and agronomic yield as a function of potassium and vase life of sunflower (*Helianthus annuus* L.) (Asteraceae)", *International Journal of Current Research,* 8, (01), 26515-26518.

INTRODUCTION

The sunflower (*Helianthus annuus* L.) is a plant with C_3 metabolism and has a melting point higher fotosaturación, belongs to the family Asteraceae and long it has been used for extracting a high quality edible oil (Gallegos *et al*., 2003). Due to the presence of fatty acids such as oleic and linoleic, it has been used in the manufacture of certain medications such as Oleozón,which it is used for the treatment of epidermophytosis (Ledea, 2004). Among other uses, it can cite as food for livestock (Escalante *et al*., 2008), bioremediation of soils affected by heavy metals in tailings derived from remnants of mining (Maldonado *et al*., 2002), and in recent years it has been grown as an ornamental (Chavarría and Vera, 2010). Respect to potassium is mentioned that is essential for growth and development of crops macroelement, as it influences the stomatal opening and closing, thus regulating perspiration and fruit quality by keeping the tissue cells in the turgid fruits, for this reason involved in the quality thereof and increases the postharvest life even flowers (Azcón and Bieto, 2000; Salisbury and Ross, 1994). So under this trend Molina (2006), mentions that potassium plays an important role in the translocation and storage photoassimilates also convey resistance to pests and diseases by increasing the size of the cell walls. Meanwhile Balanguera *et al*. (2014) indicate that potassium permanganate $KMnO_4$, it is an oxidizing ethylene,

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thus inhibiting the effect of this in the cell tissues thus reducing their negative impact on the post-harvest of flowers. For the foregoing reasons, the main objective of this research was to evaluate the effect of four levels of potassium fertilization in the field, on the postharvest life of sunflower inflorescences. So the hypothesis was: potassium applied field at four levels, will affect the postharvest life of sunflower and the agronomic yield and biological.

MATERIALS AND METHODS

This study was conducted in two stages field and laboratory in the premises of the Universidad Tecnológica de Tehuacán in San Pablo Tepetzingo, Tehuacán Puebla at 18º24´ 51" north latitude, 97º 20′ 00′′ west longitude and 1409 meters of altitude, in a climate Bs_1h' (h)eg which corresponds to a dry climate, with more than 18ºC and 27ºC lower than annual average temperature in the coldest month temperature lower than 18ºC, annual rainfall greater than 400 mm and less than 600 mm during the months of June to September and intraestival presence of drought, a swing of more than 7ºC and less than 14ºC temperature, the hottest month occurs before the summer solstice for the area occurs during the month of May (García 2005). The germplasm used were achenes of cv. Victoria donated by the genebank Ecophysiology crop of Colegio de Postgraduados, which were planted on July 28, 2015, on beds of 25 meters of long and 1.20 meters of wide, on a soilLitosol with pH 8.6, CIC 27 meq, percentage base saturation of 70%, 2.0% organic matter and an initial level of nitrogen and phosphorus of 6.3 and 7.2 mg kg^{-1} respectively. The topological arrangement under which the seed was sowin (0.20 x 0.80 m) and resulting in a population density of 6.25 plants m^{-2} (Diaz *et al*, 2010).The entire experiment was fertilized with a formula 100-80, whose sources were urea (46% N) and calcium triple superphosphate (46% P_2O_5).The experimental design used for this step was a randomized complete block evaluated under on the mathematical model $Y_{ij} = \mu + \tau_{ij} + \beta_j + \varepsilon_{ij}$ where: Y_{ij} is the response variable of the i-th level of potassium in the j-th block; μ is the true overall average; τ_i is the effect of the i-th potassium; β_j is the effect of the j-th block and ε_{ij} is the experimental error of the i-th level of potassium in the j-th block. The treatments were four levels of potassium 0, 50, 100 and 150 kg ha^{-1} of K_2O and three repetitions (4x3) = 12 experimental units.The source of the nutrient was potassium chloride, which was applied at planting time. The response variables were: agronomic yield, which is determined by weighing the total of achenes per plant and expressing the result in g $plant^{-1}$, weighing the total biological yield of biomass and expressed in $gplant^{-1}$ and harvest index, which it was determined by the equation IC = RA / RB where: IC, is the harvest index; RA, RB and agronomic yield, is the biological yield (Escalante and Kohashi, 1993). For the laboratory phase, sunflower inflorescences are used in R_4phenological stage, corresponding to the reproductive stage when the ray florets are visible from the top of the chapter before it opens (Hernandez and Larsen, 2013; Schneiter and Miller, 1981), which were cut in the morning and placed in tap water to avoid dehydration. The experimental design for laboratory stage was completely randomized under the model $Y_{ij} = \mu + \tau_i + \varepsilon_{ij}$ where: Y_{ij} is the response variable of the i-th level of potassium in the j-th repetition; μ is the true overall average; τ_i is the effect of the i-thlevel of potassium; ε_{ij} is the experimental error of the i-th level of potassium in the j-th repetition (Infante, 1990). The treatments were four levels of potassium fertilizer 0, 50, 100 and 150 kg ha-1 and four replications (4x4) = 16 experimental units. This consisted of a container with capacity of one liter and the inflorescence cut in the phenological stage over R_4 running water with adjusted pH 6.0 with NaOH or HCl as appropriate using a potentiometer HANNA model H19813-5 inflorescence. The response variables were: vase life, counting the days until the ray florets of inflorescence had good looks; diameter section, measuring the cross-shaped using a digital vernier model Blue V-4; percentage of mature tubular flowers, covered by calculating the tubular disc flowers inflorescence area, also known as annulus by the formula $A = \pi (R^2-r^2)$ where: A; is the area of the annulus covered by the tubular flowers of the chapter, π; 3.14159 R; Chapter larger radius, r; Chapter smaller radius; consumed water, calculating milliliters of water consumed daily by the formula $AC = V_2-V_1$, where: AC is the water consumed, V_2, the volume of water after the start of the experiment, V_1, initial volume day.

In both phases of the experiment when the variables were significant, we applied the multiple comparison test of Tukey at a level of significance of 5% probability of error.

RESULTS AND DISCUSSION

In Table 1, the results of analysis of variance and multiple comparison test are presented and you can see that there were significant differences for both variables response, compared to the coefficient of variation that ranged between 15 and 28% thus showing that the data were reliable. Regarding the agronomic yield the greatest corresponded to 100 and 150 kg ha^{-1} potassium with 25 and 30 g $plant^{-1}$ respectively, while the lowest was 50 and 0 kg ha^{-1} with 15 and 12 g $plant^{-1}$, resulting also statistically equal. The same trend occurred in the biological yield, as high levels of potassium yielded the highest values of dry biomass with 110 and 112 g $plant^{-1}$ and less corresponded to the witness and 50 kg ha^{-1} of K_2O, regarding the dynamic behavior of this parameter, Figure 2 shows that this behaved in ascending order from 0 to 60 days after of sowing (das), then present an asymptotic behavior of 60-90 (das) time in which the maximum dry weight was reached, This behavior occurred in all treatments.

Table 1. Analysis of variance and multiple comparison test for two variables in response to four levels of potassium in the Universidad Tecnológica de Tehuacán. Summer-Autumn cycle. 2015

Treatment	AY	TBY
Kg ha^{-1}	g $plant^{-1}$	
0	12.0 b	85.5 b¶
50	15.0 b	96.3 b
100	25.0 a	110.0 a
150	30.0 a	112.0 a
ANVA	*	*
HSD	7.5	8.9
CV%	15.2	28.5

¶Values within the column with the same literal are statistically equal according to Tukey P≤0.05; AY, agronomic yield; TBY, total biological yield; ANVA, analysis of variance; HSD, honest significant difference; CV, coefficient of variation; *, **; n.s, significant at 0.05; 0.01 and not significant.

Table 2. Analysis of variance and multiple comparison test four variables response sunflower (*Helianthus annuus* L.) under four levels of potassium fertilization. In the Universidad Tecnológica de Tehuacán.Summer-Autumn cycle. 2014

Treatment	VL	DC	PTF	WC
Kg ha^{-1}	days	cm	%	ml
0	7.3 b	6.5 b	80.1 a	210.0 a¶
50	7.9 b	7.0 b	85.6 a	215.0 a
100	10.2 a	9.5 a	90.3 a	213.0 a
150	11.5 a	10.0 a	92.1 a	217.0 a
ANVA	*	*	n.s	n.s
HSD	2.0	2.1	n.s	n.s
CV%	19.50	22.50	25.1	23.6

¶Values within the column with the same literal are statistically equal according to Tukey P≤0.05; VL, vase life; DC, diameter chapter; PTF, percentage of tubular flowers; WC, water consumed; ANVA, analysis of variance; HSD, honest significant difference; CV, coefficient of variation; *, **, n.s, significant at 0.05; 0.01 and not significant.

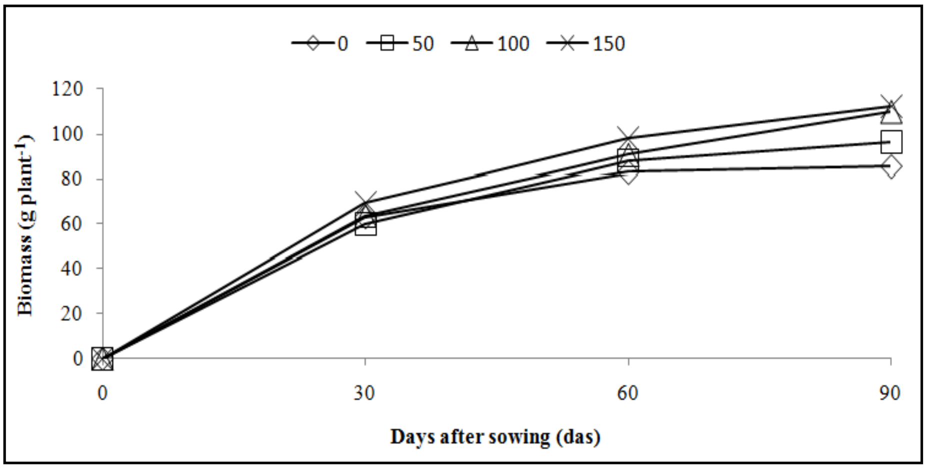

Figure 1. Sunflower (*Helianthus annuus* L.) biomass dynamics under four potassium levels in the Universidad Tecnologica de Tehuacan.Summer-Autumn cycle. 2015

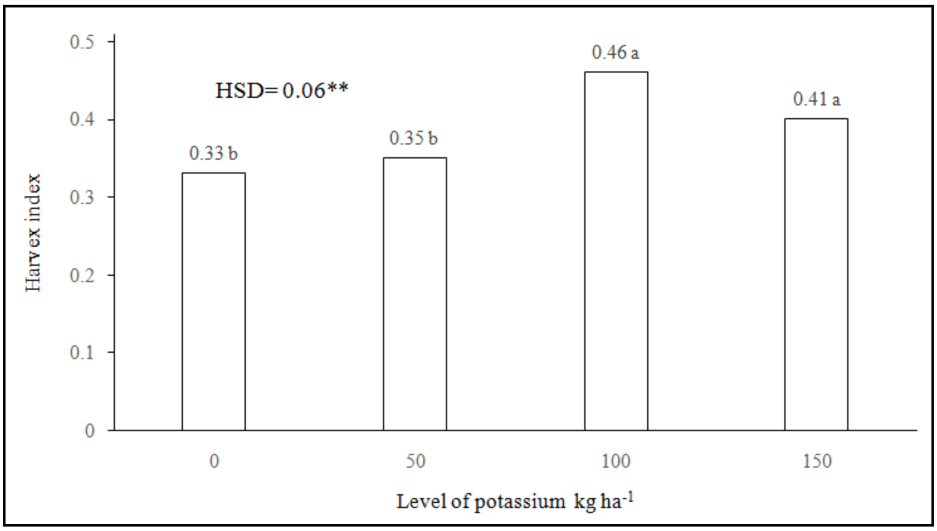

Figure 2. Harvest index in sunflower (*Helianthus annuus* L.) under four levels of potassium in the Universidad Tecnologica de Tehuacan. Summer-Autumn cycle. 2015. HSD, honest significant difference

As reported in the present study it differs from that reported by Agüro *et al*. (1999), who reported a yield of 24 g plant^{-1}well-being 4% lower than the yield obtained in this research, although this increase is relatively small, can be significant and result of different population densities used, and different genotype where both studies were performed. Another aspect that may influence this fact may open pollinated material that was sown in this study area has a higher phenotypic plasticity hybrid compared as demonstrated by studies (Quintero and Barraza, 2009; Kohashi, 1990; Bradshaw, 1965), who agree that the open-pollinated materials possess greater genetic diversity, have greater adaptability to different environmental conditions, genetically improved materials such as hybrids. The harvest index is presented in Figure 2, and it can be seen that the largest was 100 and 150 kg ha^{-1} of K_2O, with 0.46 and 0.41, indicating that 46 to 41% of the biomass produced during the process of photosynthesis, it was assigned to the body of anthropocentric interest in this case to aquenio. This has been proven by Rodriguez (1992), who mentions that potassium deficiencies caused by poor nutrition of this macronutrient, causing a decrease in photosynthesis significantly affecting translocation of carbohydrates, affecting crop yields and distribution per se biomass in the organ of interest, which affect parameters such as harvest index, Besides potassium deficiency in plant tissues, it forces the plant to synthesize putrescine, catabolic substance which is responsible for cell death (Taiz and Zeiger, 2003). Regarding the vase life results are presented in Table 2, and shows that there were significant differences for vase life and diameter chapter, while the percentage of mature tubular flowers and water consumed, were not significant, and this thus the coefficient of variability for all variables under study ranged from 19.50 and 25.1%, indicating that the experimental data were reliable. In relation to the means test for vase life, as was achieved with the application of 100 and 150 kg ha^{-1} of potassium, 10.2 and 11.5 days, while the lowest was for the witness and 50 kg ha^{-1} with 7.3 and 7.9 days respectively. Relative at the diameter of chapter, this followed the same trend as the vase life because the larger diameters correspond to higher doses with 9.5 and 10.0 cm, while the lower doses diameters likewise were reduced to 6.5 and 7.0 cm. The percentage of mature tubular flowers and water consumed, turned out to be not significant despite having numerical differences. This response increased vase life at high doses potassium 100 and 150 kg ha^{-1} (K_2O), responsive to potassium enters the metabolic system of cells, forming salts with the organic acids within the protoplasm, that regulate cell osmotic potential, thereby regulating the content of internal dilute and thus keeping the cells turgid ray florets sunflower inflorescence (Fageria, 2001).

Conclusion

Open-pollinated cultivar sunflower used in this study responded positively to potassium application in the field, thus increasing the agronomic performance and biological. So as vase life, it was able to increase the implementation of this nutrient, as well as the diameter of chapters postharvest evaluated. The increased potassium fertilization in the field, did not affect water consumption and the percentage of mature tubular flowers.

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