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Original Article:

Effects of Application of Biological and Chemical Potassium Fertilizer and Corm Weight on Physiological Traits and Flower Yield of Saffron (*Crocus sativus* L.)

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Extended Abstract

Introduction: Potassium is the most abundant inorganic cation in plant tissues that plays a major role in physiological processes, especially in growth and metabolism. Although there is substantial evidence about the effects of potassium fertilizer on increasing the qualitative and quantitative yield of plants, little is known about the effects of applied potassium on saffron and the improvement of the quality and yield of the saffron flower. The purpose of this study was to evaluate the effects of biological and chemical potassium fertilizer and corm weight on some physiological traits and yield of saffron (*Crocus sativus* L.).

Materials and Methods: An experiment was conducted as factorial based on a randomized complete block design with three replications and eight treatments at the saffron research field of the College of Aburaihan, the University of Tehran during 2015-2016. Experimental treatments included two levels of potassium sulfate fertilizer (0 and 200 kg. ha^{-1}) as the first factor, two levels of Potabarvar-2 biofertilizer (0 and 100 g. ha^{-1}) as the second factor, and two corm weights including small (3-5 g) and big (8-10 g) were the third factors. Potabarvar-2 biological fertilizer used in the research has a set of the most effective potassium-releasing bacteria called *Pseudomonas spp.* Strain s19-1 and *Pseudomonas spp.* strain s14-3, which was inoculated with corms before cultivation. Potassium chemical fertilizer treatment of potassium sulfate type and in the amount of 200 kg per was used as pre-planting in the soil of the desired plots. The corms were planted at a distance of 10 cm on the row at a depth of 15 cm at the end of June. In order to increase the colonization of bacteria around the corm, irrigation was done after planting and then summer irrigation was done on the first of September, the appearance of the first flower was at the beginning of November and the end of flowering was in the

middle of December. In this research, functional traits including the number of flowers, flower fresh weight, stigma dry weight, and physiological traits including petal anthocyanin, leaf soluble protein, and total leaf soluble carbohydrate were measured.

Results and Discussion: the results of this experiment indicated that the application of potassium, especially in the form of biofertilizer, had positive effects on improving flowering and increasing the number of flowers in both groups of saffron corms, especially small corms (3-5 grams). Also, the increase in the fresh weight of flowers was evident in the combined application of biological and chemical fertilizers, especially in large corms (8-10 grams). Stigma dry weight increase as an important component of saffron performance was affected by the application of chemical fertilizer, although biological fertilizer also caused a significant increase in this functional trait compared to the control. The application of potassium sulfate in combination with biological fertilizer had the greatest effect on increasing the concentration of total carbon hydrates, total leaf protein, and petal anthocyanin content. Therefore, in most of the measured traits, biofertilizer has positive effects, and to achieve the maximum flower yield and quality of saffron per unit area, biofertilizer alone (100 grams per hectare) or in combination with smaller amounts of potassium sulfate chemical fertilizer should be used. Applied fertilizers led to increasing in flower yield through an enhancement in the number of flowers, fresh weight of flower, and dry weight of stigma. Application of biological fertilizer alone led to an increase of three times the number of flowers in a big corm in comparison with a small corm and normal. There was a significant difference between normal treatment and application of both mixed fertilizers on the concentration of total carbohydrate and protein of the leaf and anthocyanin of the petal.

Conclusion: In summary, the results of this experiment indicated that the application of big corms by inoculating them with biological fertilizer of potassium, in addition to using smaller amounts of potassium sulfate chemical fertilizer before sowing would be affected the increase of flower yield and improve physiological traits effectively growth. Therefore, the use of biological potassium fertilizer led to a decrease of using of chemical fertilizers and will be promising for sustainable agriculture and reducing the environmental pollution.

Conflict of Interest: The authors declare no potential conflict of interest related to the work.

Keywords: Anthocyanin, Carbohydrate, Potabarvar-2, Potassium sulfate, Saffron stigma.

Five Important References

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Table 1. Physical and chemical properties of field soil (Depth 0-30 cm)

pH	Texture	Nitrogen (mg/kg)	Available phosphorus (mg/kg)	Available potassium before fertilizing (mg/kg)	Available potassium after fertilizing (mg/kg)	EC (dS/m)	Organic matter (%)
7.5	Loamy clay	0.08	29.1	115.2	137.1	1.7	0.4

Table 2. Analysis of variance (mean of squares) for the effects of potassium fertilizer treatments and corm weight on saffron yield traits

S.O.V	df	Number of flower	Fresh weight of flower	Dry weight of stigma
Replicate	2	0.29^{ns}	0.011^{ns}	0.0014^{ns}
Bio-fertilizer (a)	1	192.61**	87**	1.025**
Chemical fertilizer (b)	1	20.63**	38**	0.00026^{ns}
Corm weight (c)	1	73.50**	34**	1.640**
a×b	1	42.64**	1.5**	0.540**
a×c	1	6*	3.2**	0.0042^{ns}
b×c	1	0.16^{ns}	8**	0.0013^{ns}
a×b×c	1	10.61**	5**	0.00026^{ns}
(Error)	14	0.81	0.042	0.0025
(%cv)	-	10.14	11	8.52

ns, * and **: represent non-significant, significant at 5% and 1% levels, respectively.

Table 3. Analysis of variance (mean of squares) for the effect of potassium fertilizer treatments and corm weight on saffron physiological traits

S.O.V	df	Leaf total carbohydrates	Leaf protein	Petal anthocyanin
Replicate	2	0.000028^{ns}	0.04^{ns}	0.015^{ns}
Bio-fertilizer (a)	1	0.0058**	2.52**	0.55**
Chemical fertilizer (b)	1	0.0071**	2640.14**	0.06*
Corm weight (c)	1	0.0010**	81.25**	0.0031 ^{ns}
b×a	1	0.0088**	181.6**	0.63**
c×a	1	0.00083**	287.2**	0.0039^{ns}
c×b	1	0.0073**	1083.3**	0.0024 ^{ns}
c×b×a	1	0.0015**	687.04**	0.0032 ^{ns}
(Error)	14	0.0000079	0.18	0.0044
(%cv)	-	6.24	7.45	4.54

ns, * and **: represent non-significant, significant at 5% and 1% levels, respectively

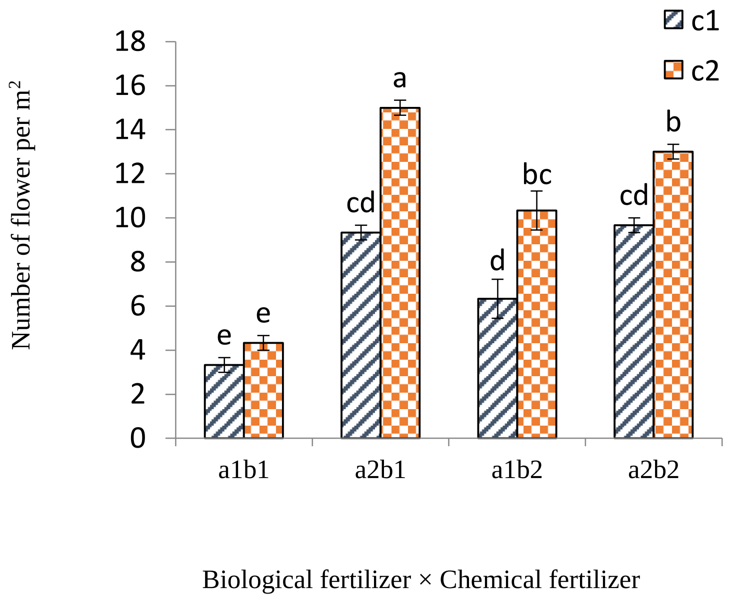

Fig 1. The mean comparison of the triple interaction effect of potassium biological fertilizer (a1= 0 g/ha, a2= 100 g/ha), potassium chemical fertilizer (b1= 0kg/ha, b2= 200 kg/ha), and corm weight (c1= small corm, c2= big corm) on number of the saffron flower

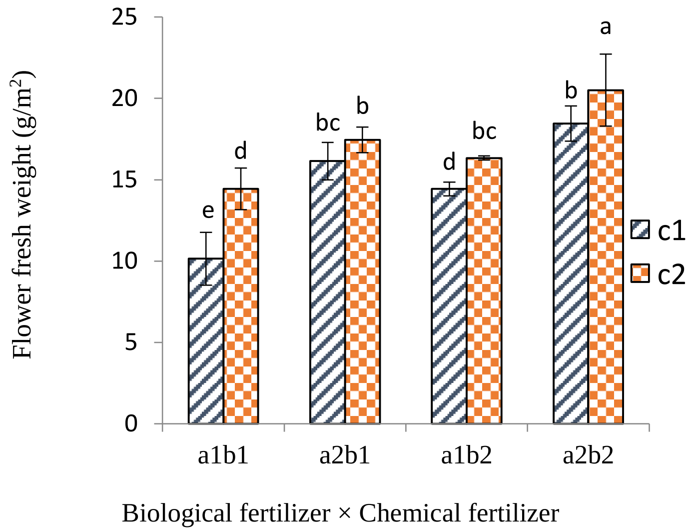

Fig 2. The mean comparison of the triple interaction effect of potassium biological fertilizer (a1= 0 g/ha, a2= 100 g/ha), potassium chemical fertilizer (b1= 0kg/ha, b2= 200 kg/ha), and corm weight (c1= small corm, c2= big corm) on fresh weight of the saffron flower

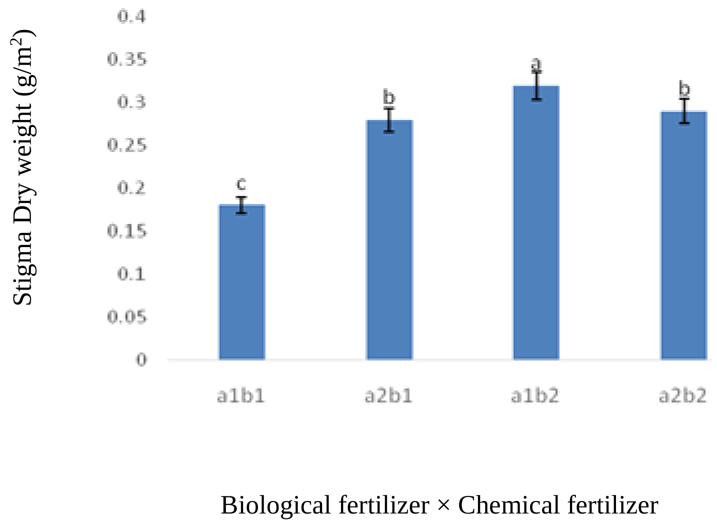

Fig 3. The mean comparison of the dual interaction effect of potassium biological fertilizer (a1= 0 g/ha, a2= 100 g/ha) and potassium chemical fertilizer (b1= 0 kg/ha, b2= 200 kg/ha) on the dry weight of stigma

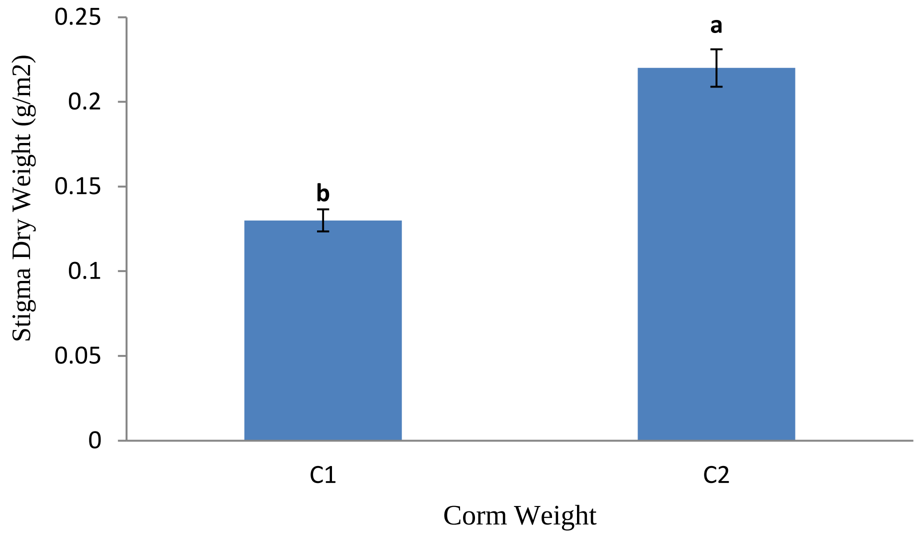

Fig 4. The mean comparison of the main effect of corm weight (c1= small corm, 3-5 g, c2= big corm, 8-10 g) on the dry weight of stigma

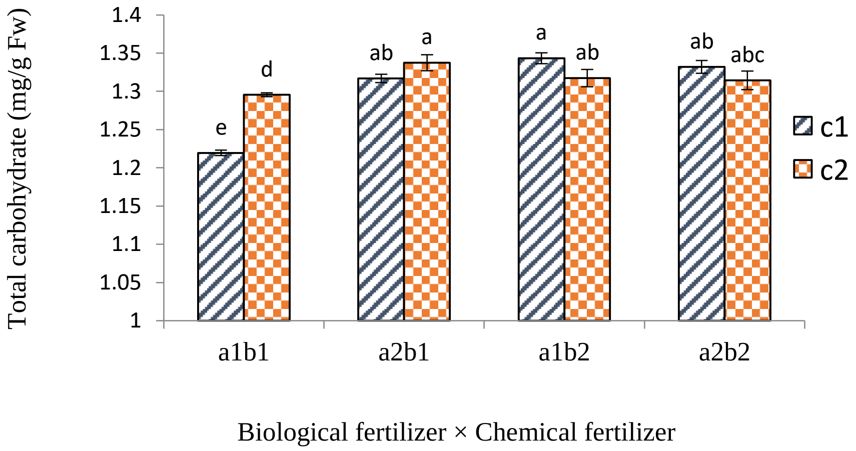

Fig 5. The means comparison of triple interaction effects of potassium biological fertilizer (a1= 0 g/ha, a2= 100 g/ha), potassium chemical fertilizer (b1= 0kg/ha, b2= 200 kg/ha) and corm weight (c1= small corm, c2= big corm) on total carbohydrate

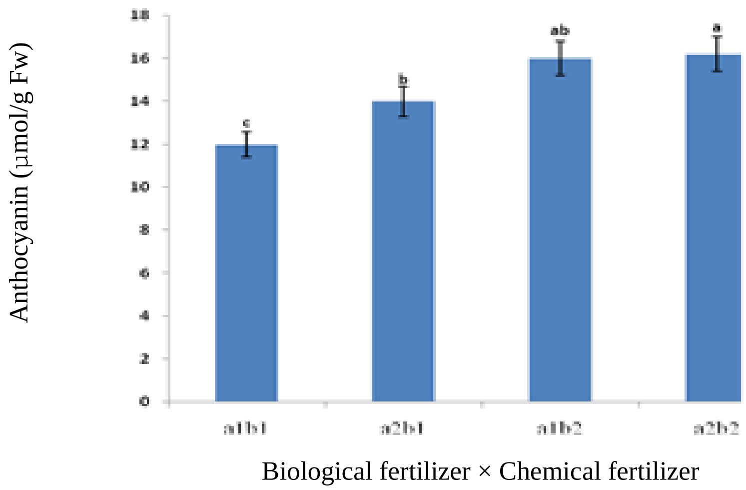

Fig 6. The mean comparison of the dual interaction effect of potassium biological fertilizer (a1= 0 g/ha, a2= 100 g/ha) and potassium chemical fertilizer (b1= 0 kg/ha, b2= 200 kg/ha) on anthocyanin of petal

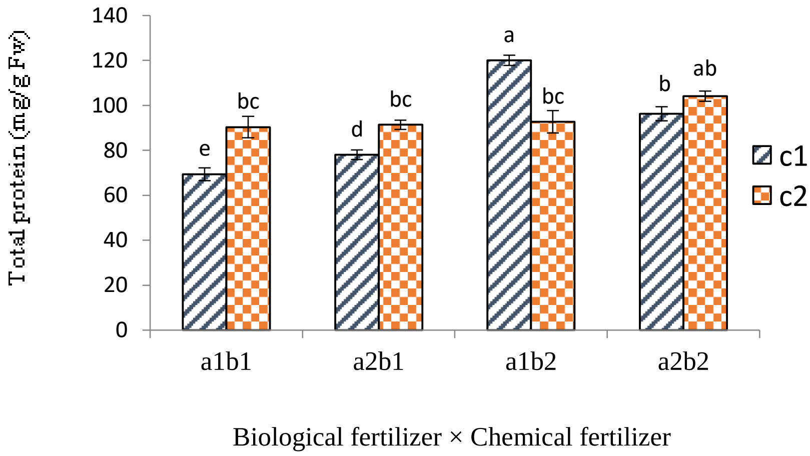

Fig 7. The mean comparison of the triple interaction effect of potassium biological fertilizer (a1= 0 g/ha, a2= 100 g/ha), potassium chemical fertilizer (b1= 0kg/ha, b2= 200 kg/ha), and corm weight (c1= small corm, c2= big corm) on total protein

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