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Influence of Corm Weight and Planting Distance on Production of Saffron in Agro-climatic Condition of Kabul

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ABSTRACT

The effect of phosphorus and plant density on floral yield and corm production of *Crocus sativus* was studied at horticulture department, faculty of agricultural Kabul University during 2019-2020. Four different phosphorus (P) doses i.e. 0, 20, 40 and 60 kg ha^{-1} were applied to five different densities viz. 242, 107, 54, 30 and 20 plants m^{-2}. The experiment was laid out in randomized complete block design with split plot arrangements. P effect was largely non-significant, whereas planting densities had considerable effects. Maximum days to sprouting (29.8), and in the second year maximum saffron yield ha^{-1} (10.4 kg) were produced by 242 plants m^{-2}, while minimum in these were recorded at 20 plants m^{-2} density. Maximum stigma weight (5.33 mg), Maximum flowers size (3.8 cm) was produced by 30 plants m^{-2} density at 20 kg ha^{-1} P, and maximum flowers per plant (1.5) were produced by 20 plants /m^{-2} densities at 20 kg ha^{-1} P. Minimum flowers per plant (1.0) were produced by corms at 107 plants m^{-2} density supplied with 60 kg ha^{-1} P, and minimum flower size (2.8 cm) was observed in plants grown at 54 m^{-2} density fed with 40 kg ha^{-1} P.

Keywords: Complete flowers, Orange, Plants, Stigma, Weight

INTRODUCTION

Saffron (*Crocus sativus*) is a perennial bulbous plant belonging to family Iridaceae. The word saffron is derived from Arabic word *Zafran*, which means orange yellow colour, because it was exclusively used for colouring as well as flavouring dishes, especially those of rice (Fatemeh and Akbar, 2023). The word Crocus is derived from Greek word *KroKus* which means something like a string, fibre or hair having horns. In 1754, the well-known Swedish botanist Carolus Linnaeus converted Krokus to its present Latin form *Crocus* (Kaffi, 2002). The genus Crocus comprises of more than 100 species, but only 30 of them are commercially cultivated for ornamental purposes, the majority of which are spring flowering, producing flower shades of yellow, white, purple, blue and bi-colour (Wazir, 2005). *Crocus sativus*, on the other hand, is a fall flowering species. It is commercially used (alongside its ornamental use) as a spice for flavouring and colouring foods, as well as in medicines (Olga *et al.* 1996).

The exact information about the origin of saffron is not clear. Some authors mentioned that this plant originated from the Eastern Mediterranean region. However, others are of the opinion that it originated from Khorasan (now Afghanistan and Iran), Kashmir and Iraq areas. The crop was introduced to Europe in 711 AD during the Moorish conquest and is in continuous cultivation in Spain since then (Kaffi, 2002). Medicinally, saffron has a long history as part of traditional healing medicines. Modern medication has also discovered saffron as having anti-carcinogenic (cancer suppressing), anti-mutagenic (mutation preventing), anti-oxidant and anti-depression properties. Saffron is also used as carminative, diaphoretic, emmenagogue (regulating the menstrual cycle), strengthening stomach, appetizer, improving central nerves system and anti-spasmolytic. Moreover, it is analgesic and also suitable for pain relief in mouth and gums tissue membranes (Hourani, 2023; Abdullaev, 1999; Negbie, 1999; Fikrat *et al.*, 2002; Kaffi, 2002; Noorbala *et al.*, 2005 and Sammbamurty, 2006).

Crocus grows best in well drained sandy loam soil of medium fertility, having soil pH range of 5.8-7.8. The soil should be free from weeds, pathogens and deep ploughed (Biswas, *et al* 1975, Peare, 1983, Shahinda, 1990; Snow *et al*., 1997; Azizbekova, 1999; Ait-aubagou., *et al*; 1999, Kaffi, 2002). Crocus requires nitrogen (N) in small quantity, while adequate amount of phosphorus (P) and potash (K) should be supplied for maximum production. P affects the shape and colour of flower and root development, whereas, K improves flower colour and resistance against diseases. However, the proper dose of these essential elements for *Crocus* production, especially in Peshawar region is not known. Experiments conducted on *Crocus* and some other corm ornamentals in different organic media have shown that media with high P content had a prominent effect on corm production (Folle, *et al*. 1995, Onayango, 1997, Nknonge, *et al*.1998; Behnia., *et al;* 1999; Shah, 2004; Ali, 2005; Wazir, 2005). Apart from that, developing a production technology package for this area is also needed. Optimizing plant spacing is an important component of that package. Keeping in view the importance of the above mentioned factors, an experiment was designed to meet the following objectives: a) to observe the effect of phosphorus on saffron yield and to find out the effect of planting distance on flower yield.

MATERIALS AND METHODS

Research site and measurements

An experimental trial on the effect of phosphorus and plant density on flower yield of *Crocus sativus* was conducted at the Horticulture form, Dept. of Horticulture, Faculty of Agricultural, Kabul University during 2019-2020. The following parameters were studied during the course of experiment. The days to sprouting were counted from date of planting to the date of emergence and the average was calculated. Days from sprouting till the appearance of flowers were also counted. The total flowers per plant were counted and the flower size (diameter) was measured with the help of vernier caliper. Stigma weight was taken with the help of a sensitive electronic balance (Shamadzu Corporation, Made U.S.A).

Experimental design and Field Preparation

The experiment was laid out in Randomised Complete Block Design (RCBD) with Split Plot arrangement. Special modifications were made into the design while plotting it into the field. This modification is known as Fan or Wagon Wheel design (Peare, 1983) which is specific for plant spacing experiments. In this case the planting distance changes in two directions, i.e. plant to plant and row to row distances change simultaneously. Near the centre the planting distance is kept smaller and it increases towards the periphery. Starting from the centre, the plants were planted at 5, 10, 15, 20, 25, 25 cm distances. Similarly, 7 rows were planted, separated 5 cm near the centre and 25 cm at the periphery, from each other. These provided a guard row on all the four sides and 5 planting densities each having 5 plants were obtained. One wheel represented one replication which was divided into four quarters to accommodate four phosphorus doses. Each quarter (P dose) was further split into different planting densities. The detail of plant spacing is given in table 3.1, which shows the accumulated distances. The different Phosphorus (P) doses were applied to the main plots, planting densities were assigned to sub plots. There were twenty treatments, each replicated three times.

The field was thoroughly prepared before planting the corms, and the assigned fertilizer dose was applied to each treatment. Nitrogen (N) and potassium (K) were kept constant at 10 and 20 kg ha^{-1} respectively, while four different P doses were applied to the main plots in the following manner.

D1= 0 kg ha^{-1}, D2= 20 kg ha^{-1}, D3= 40 kg ha^{-1} and D4= 60 kg ha^{-1}

N was given in the form of urea and K in the form of potassium sulphate. Single super phosphate (SSP) was used for supplying P in different doses. P and K were incorporated in soil before planting the corms. N was given in two split doses at active growth stage. Healthy corms of average size (2.5-3.0 cm) and weight (10g) were selected, brought from Herat province of Afghanistan. The sheaths (outer dry husk around the corms) of the corms were removed before planting for quick sprouting (Munshi et al., 1989). Each main plot was split into 5 sub plots and five corms of *Crocus sativus* were planted at 10 cm depth.

Statistical Procedures Employed

The data recorded on different parameters were subjected to analysis of variance (ANOVA) technique to observe the difference between the different treatment as well as their interactions. In cases where the differences were significant, the means were further assessed for differences through Least Significant Difference (LSD) test. Statistical Computer Software, MSTATC (Michigan State University, USA) was applied for computing both the ANOVA & LSD.

RESULTS

The results regarding days to emergence, days to flowering, number of flowers, flower size, stigma weight, number of sprouts, and saffron yield ha-[1] of *Crocus sativus* are presented in the following parameters.

Days to sprouting

The data recorded for days to sprouting are given in Table 1. The analysis of variance (ANOVA) shows that days to sprouting were significantly ($P \le 0.05$) affected by planting densities while, the phosphorus doses had no effect. The interaction between planting densities and phosphorus was also non-significant. A comparison of the means for planting densities shows that maximum days to sprouting (29.8) were taken by 242 plants m^{-2}. The rest of the planting densities i.e. 107, 54, 30 and 20 plants m^{-2} behaved alike taking 27.4, 27.7, 26.7 and 26.7 days to sprouting respectively.

The reason for this difference is not clearly known, however, the corms grown at 242 plants m^{-2} density were perhaps too close to get enough moisture compared to the corms grown at other densities. This lack of moisture may have delayed the sprouting in the corms grown at this particular density. Moreover, crocus requires cold temperature (vernalization) for sprouting. The close planted corm may produce heat due to respiration that might be delayed sprouting.

Table 1. Days to flowering as affected by different doses of phosphorus and plant density (from sprouting till flower appearance)

Planting Densities (Plants m^{-2})	Phosphorus Doses kg ha^{-1}				Mean
	0	20	40	60	
242	5.5 j	6.6 g-j	7.0 f-j	5.8 ij	6.3 C
107	8.3 c-f	10.6 a	9.9 abc	10.0 ab	9.7 A
54	7.6 d-h	8.6 b-e	8.0 d-g	7.0 f-j	7.8 B
30	6.2 hij	8.6 b-e	8.3 c-f	10.1 ab	8.3 B
20	7.2 e-i	7.7 d-h	7.4 d-i	8.8 bcd	7.8 B
Mean	7.0	8.5	8.1	8.4	

LSD value for plant densities at α 0.001 = 1.079
LSD value for interaction at α 0.05 = 1.605
Means followed by the same letters are not significantly different at 1% (upper case) and 5% (lower case) level of significance. 107 m^{-2} densities (9.7 days). The rest of plant densities i.e. 54, 30 and 20 Plants m^{-2} had similar effects taking 7.8, 8.4 and 7.8 days to flowering respectively.

Days to flowering

The data regarding days to flowering are presented in Table 2. The ANOVA showed that planting densities had significantly ($P \le 0.001$) affected the days to flowering, while the effect of phosphorus was non-significant. Similarly the interaction between phosphorus dose and planting densities was also significant ($P \le 0.05$). The effect of phosphorus was non-significant, although early flowering (7.0 days) occurred in plants at 0 kg ha^{-1} P (Control), while flowering was delayed (8.4 days) in plants supplied with 60 kg ha^{-1} P. The interaction between phosphorus and plant density showed that delayed flowering (10.7 days) took place in plants grown at 107 plants m^{-2} supplied with 20 kg ha^{-1} P, while the earliest flowering (6.2 days) occurred in plants at 30 plants m^{-2} density with 0 kg ha^{-1} P (control).

The effect of phosphorus was non-significant, because during flowering the mother corms had their own reserved food which was used for sprouting and flowering and no P from the soil was used. It is usual that the corms start rooting at the same time as they are sprouting and flowering. So the nutrients taken from the soil (including P) are later used for leaves and then daughter corms and cormels formation.

The data regarding the number of flowers plant $^{-1}$ are presented in Table 2. The analysis of variance revealed that the number of flowers per plant was not affected by both phosphorus doses and plant densities. However, the interaction between phosphorus doses and different plant densities was significant ($P \le 0.05$). The mean values of interaction between phosphorus dose and plant densities showed that corms grown at 20 m^{-2} and

30 m^{-2} densities produced maximum flowers per plant (1.53 and 1.50 respectively) when fed with 20 kg ha^{-1} P. However, it is surprising that they were closely followed by corms grown at 242 m^{-2} densities (1.33 flowers) supplied with no P dose (control). Most of the treatments produced minimum flowers (1.00) plant^{-1}. The reason for these discrepancies is not known and is worth further investigation.

Table 2. Flower per plant as affected by different doses of phosphorus and plant densities.

Planting Densities (Plants m^{-2})	Phosphorus Doses kg ha^{-1}				Mean
	0	20	40	60	
242	1.33 abc	1.00 d	1.00 d	1.00 d	1.08
107	1.00 d	1.00 d	1.20 cd	1.00 d	1.05
54	1.17 cd	1.23 bcd	1.07 cd	1.00 d	1.12
30	1.07 cd	1.50 ab	1.10 cd	1.17 d	1.21
20	1.13 cd	1.53 a	1.03 d	1.20 d	1.23
Mean	1.14	1.23	1.08	1.07	

LSD value for interaction at α 0.05 = 0.29975

Means followed by the same letters are not significantly different at 5% level of significance.

Flower size

The data on flowers size (diameter) are presented in Table 3. The analysis of variance revealed that flowers size was not affected by both phosphorus doses and plant densities. However, the interaction between phosphorus doses and plant densities was significant ($P \leq 0.05$).

Table 3. Flower size (cm) as affected by different doses of phosphorus and plant densities.

Planting Densities (Plants m^{-2})	Phosphorus Doses kg ha^{-1}				Mean
	0	20	40	60	
242	3.2 bcd	3.2 bcd	3.6abc	3.5 abc	3.4
107	3.2 bcd	3.2 bcd	3.6 ab	3.5 abc	3.3
54	3.6 ab	3.1 cd	2.8 d	3.2 bcd	3.2
30	3.3 bcd	3.8 a	3.2 bcd	3.3 abc	3.4
20	3.5 abc	3.4 abc	3.1 bcd	3.2 bcd	3.3
Mean	3.4	3.3	3.4	3.4	

LSD value for interaction at α 0.05 = 0.4763

Means followed by the same letters are not significantly different at 5% level of significance

Stigma weight

The data recorded for stigma weight is given in Table 4. The analysis of variance revealed that phosphorus doses had no effect on stigma weight, while it was significantly ($P \leq 0.001$) affected by plant densities. The interaction between phosphorus doses and plant densities was also non-significant. This increase in stigma weight is due to the larger feeding area for the plant. As the distance between plants increases, more nutrients, water and light are available to the plant. Therefore, the stigma produced by plant is higher in weight. However, fewer flowers per unit area would be obtained from lower planting densities, which may reduce stigma yield per unit area if grown at lower densities. This was also observed by Bullitta et al. (1996), who planted corms at 33, 40, 50 and 67 m^{-2} densities and obtained the highest dried stigma yields at the greatest planting density.

Table 4. Stigma weight (mg) as effected by different doses of phosphorus and plant densities.

Planting Densities (Plants m^{-2})	Phosphorus Doses kg ha^{-1}				Mean
	0	20	40	60	
242	4.43	4.36	4.06	4.30	4.29 B
107	5.00	4.93	4.90	5.23	5.02 A
54	5.10	5.06	5.16	5.23	5.14 A
30	5.13	5.33	5.50	5.23	5.30 A
20	5.20	5.46	5.16	5.46	5.33 A
Mean	4.97	5.03	4.96	5.09	

LSD value for plant densities at α 0.01 = 0.5947
Means followed by the same letters are not significantly different at 1% level of significance

The mean values indicate that corms grown at the highest density (242 plants m^{-2}) produced minimum (4.29 mg) stigma weight per plant. The rest of the planting densities, i.e. 107, 54, 30 and 20 plants m^{-2}, produced higher stigma weights (5.02, 5.14, 5.30 and 5.325 mg per plant respectively), and were at par with each other. However, a slight increase in stigma weight was observed with the decrease in planting densities.

Number of Sprouts

The data concerning the number of sprouts per plant are presented in Table 5. The analysis of variance revealed that the number of sprouts per plant was not affected by phosphorus doses, while it was significantly (P≤0.010) affected by plant densities. The interaction between phosphorus doses and plant densities was also non-significant. A comparison of the means showed that the highest plant density (242 plants m^{-2}) produced minimum (2.5) sprouts per plant.

Table 5. No of Sprouts per plant as affected by different doses of phosphorus and plant densities.

Planting Densities (Plants m^{-2})	Phosphorus Doses kg ha^{-1}				Mean
	0	20	40	60	
242	2.2	2.5	2.5	2.5	2.5 C
107	3.2	3.3	3.3	3.2	3.3 B
54	3.1	3.9	3.6	4.3	3.8 AB
30	4.0	4.3	4.3	4.0	4.2 A
20	3.8	4.0	4.2	4.2	4.1 A
Mean	3.3	3.6	3.6	3.7	

LSD value for plant densities at α 0.001 = 0.4743
Means followed by the same letters are not significantly different at 1% level of significance

DISCUSSION

The stigma produced by plant is higher in weight. However, fewer flowers per unit area would be obtained from lower planting densities, which may reduce stigma yield per unit area if grown at lower densities. This was also observed by Bullitta et al. (1996) the same result, who planted corms at 33, 40, 50 and 67 m^{-2} densities and obtained the highest dried stigma yields at the greatest planting density.

The data regarding the number of flowers plant $^{-1}$ are presented. The analysis of variance revealed that the number of flowers per plant was not affected by both phosphorus doses and plant densities. This was also observed by Mahmoodi (2021) the same result. Maximum stigma weight (5.33 mg), were produced by corms grown at 20 plants m^{-2}, while minimum number of flowers per plant (1.08), stigma weight (4.29 mg), This was also observed by Dhar et al. (1988) the same result. The experiment “Effect of phosphorus and plant density on floral yield of *Crocus sativus*” was conducted at Ornamental Horticulture Nursery Farm Department of Horticulture Faculty of Agricultural Kabul University during 2019-2020. Four different phosphorus doses i.e. 0 (control), 20, 40 and 60 kg ha^{-1} were applied to five different densities i.e. 242, 107, 54, 30 and 20 plants m^{-2}. The experiment was laid out in randomized complete block design with split plot arrangements. Phosphorus did not exhibit any effects, perhaps blocked by the high soil pH. Plant densities, on the other hand, had considerably affected most of the parameters studied during the experiment.

Maximum days to sprouting (29.8), and maximum saffron yield ha-^{1} (10.4 kg) were produced by 242 plants m^{-2}, while minimum (26.6 days) to sprouting, and minimum saffron yield ha^{-1} (1.1kg) were produced by 20 plants m^{-2} .Maximum stigma weight (5.33 mg), were produced by corms grown at 20 plants m^{-2}, while minimum number of flowers per plant (1.08), stigma weight (4.29 mg), sprout per plant (2.5), were produced by 242 plants $m^{-2.}$Maximum flowers size (3.4 cm) and sprouts $plant^{-1}$ (4.2) were produced by corms spaced at 30 plants m^{-2}, while late flowering (8.3 days) occurred at 30 plants m^{-2} density and smallest flowers (3.2 cm) were observed in plants at 54 m^{-2} densities. The interaction between phosphorus doses and planting density was also significant for some parameters. Early flowering (6.2 days) occurred in corms grown at 30 plants m^{-2} density in control (0 kg ha^{-1} P). Maximum flowers size (3.8 cm) was produced by plants at 30 m^{-2} densities at 20 kg ha^{-1} P. Delayed flowering (10.7 days) occurred in corms planted at 107 plants m^{-2} density provided with 20 kg ha^{-1} phosphorus doses. Maximum flowers per plant (1.5) were observed at 20 plants m^{-2} density supplied with 20 kg ha^{-1} P, minimum flowers per plant (1.0) were produced by plants at 107 plants m^{-2} density fed with 60 kg ha^{-1} P and minimum flower size (2.8 cm) was produced by corms grown at 54 plants m^{-2} density supplied with 40 kg ha^{-1} P.

CONCLUSION

On the bases of results obtained it is concluded that phosphorus dose had no effect on crocus growth and development. Planting densities had significant effects on floral yield and corm production. Higher per plant results were obtained at lower planting density (20 plants m^{-2}), while better per unit area (m^{-2}) results were given by higher density (242 plants m^{-2}). Thinking economically and futuristically, planting at both the densities (too high or too low) will not be useful. Planting at low density although increases (production) per plant but reduces (production) per unit area resulting in waste of land and resources. On the other hand, growing at high densities although increases production but the cost of production will be too high for the farmer to afford and future production will suffer adversely. So the intermediate plant density (54 plants m^{-2}) will the best option for smooth production during the first year as well as for the coming few years.

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REFERENCES

Abdullaev, F.I., and G.D. Freckle. 1999. Saffron in biological and medical research. In: Negbi, M. (Ed.), Saffron, *Crocus sativus* L. Harwood Academic Publishers, Australia, pp. 103–114.

Ait-aubagou, A., and M. Elotmani.1999. Saffron cultivation in Morocco, in: Saffron (M.Negbi, ed) Harwood Academic Pub. Amesterdm, pp.154.

Ali, T. 2005. Response of Freesia cultivars to different growing media under Peshawar conditions. Department of Horticulture NWFP Agricultural University Peshawar, pp. 4-53.

Azizbekova, N.S.H., and E.L. Milyaeva.. 1999. Saffron cultivation in Azerbaijan. Harwood Academic Publishers, Australia, pp. 63–71.

Behnia, M. R., A., Estilai, and B. Ehdaie.1999. Application of fertilizer for increased Saffron yield. J. Agr. Sci. 182: 9-15.

Biswas, N.R., S.P. Datta, Raychaudguri, and C. Dakshinamurthi.1975. Soil condition for the growth of saffron at Pampore (Kashmir), Ind. Jammu.Agr . Sci. pp. 413-418.

Bullita, P. M., M. E. Milia, M. Pinna, Satta, and G. M. Scarpa .1996. Initial results of the effects of different agronomic treatments on *Crocus sativus* L. in Sardinia. Studio sulla valorizzazione delle piante aromatiche ed officinali, Seminario internazionale di chiusura del progetto PIM-Sardegna, Cagliari, . Rivista-Italiana-EPPOS. 19: 131-137.

Bullita, P. M., M. E. Milia, M. Pinna., Satta, and G. M. Scarpa .1996. Sowing density and corm growth: two fundamental aspects of the cultivation of saffron. Studio sulla valorizzazione delle piante aromatiche ed officinali, Seminario internazionale di chiusura del progetto PIM-Sardegna, Cagliari, Rivista-Italiana-EPPOS. No.19-145.

Fikrat, I.Abdullaev. 2002. Cancer Chemo preventive and Tumoricidal Properties of Saffron (*Crocus sativus* L.). Society for Experimental Biology and Medicine National Institute Mexico City, pp. 20-25, 227:

Folle, F., J.W. Shuford., R.W. Taylor., A.A.Meade, and W. Tadesse. 1995. Effect of sludge treatment, heavy metals, phosphate rate, and pH on soil phosphorus. Communi Soil Sci Plant Analysis. 18: 369-381.

Humphries, J. 1996. The essential saffron companion. London, Grub Street. p.160.

Jitendra, S. 2004. Basic horticulture. Kalyani publishers. p. 87.

Kaffi, M. 2002. Saffron (Persians): Centre of excellence for Agronomy, faculty of Agriculture, Fardowsi University of Mashhad, pp.108-110.

Munshi, A. M., J. S. Sindhu, and G. H. Baba .1989. Improved cultivation practices for saffron. Ind-Farming. 39 (3): 27-30.

Negbi, M., 1999. Saffron cultivation: past, present and future prospects. In: M, Negbi. (Ed.), Saffron, *Crocus sativus* L. Harwood Academic Publishers, Australia, pp. 1–11

Nkonge, Wandera, G. Nziguheba, C.A. Palm, R.J. Buresh and P. C. Smithson, 1998. Soil phosphorus fractions and adsorption as affected by Organic and inorganic sources. Plant and Soil, pp. 159-168.

Noorbala, A.A. 2005. Hydro-alcoholic extract of *Crocus sativus* L. versus fluoxetine in the treatment of mild to moderate depression: a double-blind, randomized pilot trial. J. of Ethno pharmacology, 97 (2): 281-284

Olga, O, and M. Tsimidou. 1996. Evaluation of the colouring strength of saffron spice by UV—Vis spectrometry. Food Chem. 57 (3): 463-469.

Onyango, R. M. A., T. J. Mwangi, M. Wanyonyi, J. K. Barkutwo, and E. N. Lunzalu. 1997. Verifying the potential use of inorganic and organic fertilisers and their combinations in small holder Maize production farms in Transnzoia district. Kenya Agric. Res. Institute, Natl. Agr. Res. Centre. pp. 71-73.

Peare, S.C. 1983. The agriculture field experiments. Johan Wily and Sons.Chicherten. pp 246-251.

Sammbamurty, A.V.S.S. 2006. Dictionary of medicinal plants. CBS Publishers and Distributors New Delhi. pp. 100-101.

Shah, M. 2004. Effect of different media on the tuberization of caladium cultivars. Department of Horticulture NWFP Agricultural University Peshawar, pp. 9-45

Shahinda, H. 1990. Analysis of physical and chemical properties of soil and water related to saffron response in Ganabad area (Persian): scientific and industrial research centre of Khorasan, Iran.pp.8, 17.

Snow, C. S. R., R. H. Marrs, and L. Merrick .1997. Trends in soil chemistry and floristic associated with the establishment of a low-input meadow system on an arable clay soil in Essex. Biological Conservation, pp. 35-41.

Wazir, K. 2005. Response of Crocus (Crocus Spp.) Cultivars to different growing media. Department of Horticulture, NWFP Agriculture University, Peshawar, Pakistan, pp.4-52.