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Research Paper

Impact assessment of weed regimes on agronomic and yield traits of Saffron (*Crocus sativus* L.) under temperate conditions

Tanveer Ahmad Ahngar[1], Asif M. I. Qureshi[1*], S. A Dar[1], B. A. Alie[2], N. A Dar[1], M. H Khan[3,1], G. H Mir[1], Parmeet Singh[4], Purshotam Singh[5], Zahida Rashid[6], Fehim Jeelani Wani[2], Majid Rashid[7] and Basharat Bashir[1]

[1]*Advanced Research Station for Saffron and Temperate Seed Spices, Konibal, Pampore, 192 121;* [2]*Division of Agronomy, Faculty of Agriculture, Wadura-193201;* [3]*Division of Genetics and Plant Breeding, Faculty of Agriculture, Wadura-19320;* [4]*Directorate of Research;* [5]*Directorate of Extension;* [6]*Dryland Agriculture Research Station, Rangreth-191132;*[7]*Division of Olericulture, Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar-190025, Jammu and Kashmir, India*
[*]e-mail: *asifquresh@gmail.com*

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ABSTRACT

Weed pressure is a serious impediment to saffron cultivation and can significantly affect floral and vegetative growth. The present investigation was conducted at Advanced Research Station for Saffron & Temperate Seed Spices, SKUAST-K, Pampore, using a split-plot design, to assess the performance of 35 saffron (Crocus sativus L.) germplasm lines under two opposing weed regimes; weed-free and weedy. All evaluated traits showed significant differences between weed regimes and germplasm lines. Weed-free conditions improved critical traits such as fresh pistil weight, dry pistil weight, pistil length, tepal dimensions, and corm diameter. Genotypes G24, G4, and G31 consistently showed higher mean values under both conditions; however, these findings indicate phenotypic responsiveness rather than confirmed weed tolerance. Correlation study indicated significant positive relationships between pistil weight and floral elongation traits, emphasising their importance in reproductive yield. The study highlights the importance of timely weed management in enhancing saffron productivity and identified germplasm lines with comparatively superior performance across variable weed environments. Further physiological or molecular studies are required to validate their stability under weed stress.

Key words: Corm traits, correlation floral traits, germplasm lines, saffron, weed regime

Saffron (*Crocus sativus* L.) the world's most valuable spice, has been cultivated for centuries due to its diverse uses and high economic returns. It is derived from the dried red stigmas of the saffron flower, known not only for its unique flavor and coloring capacity in culinary applications but also for its medicinal, dyeing properties and cosmetic (Christodoulou *et al.*, 2021; Mahdavi *et al.*, 2022) due to the presence of crocin, picrocin and Saffranal (Nehvi *et al.*,2018, Hussain *et al.*, 2018). Despite excellent agro-climatic conditions, saffron productivity in India (particularly in Kashmir), remains low when compared to worldwide averages, owing to a variety of agronomic and biotic constraints (Dar *et al.*, 2022; MoAFW, 2023). Among these constraints, weed infestation is one of the most persistent and understudied issues in saffron farming. Saffron has a shallow root system, slow vegetative growth, and minimal canopy cover, making it extremely susceptible to weed pressure (Gresta *et al.,* 2009). Weeds quickly exploit soil moisture, nutrients, and light, dormant phase of saffron, when corms are unable to compete successfully (Pir *et al.,* 2008). Previous studies has shown that unmanaged weed growth reduces stigma biomass, floral development, corm size, and overall yield potential (Ahmadi & Omidbaigi, 2000; Fernández, 2004; Hosseini-Evari *et al.,* 2020; Mir *et al.,* 2025). Although herbicides are utilised frequently in many cropping systems, their use in saffron is restricted due to concerns about corm sensitivity, soil residue persistence, and potential contamination of harvestable stigmas (Kafi *et al.,* 2020; Kumar *et al.,* 2024; Wani *et al.,* 2025). Given such constraints, hand weeding is still the most common weed management approach in Kashmir; nevertheless, labour shortages and high weeding costs offer significant challenges (Sharma *et al.,* 2024a; Koocheki *et al.,* 2022). This situation emphasises the importance of looking at new solutions for integrated weed management. One such technique is comparing the phenotypic performance of various saffron germplasm lines in different weed situations. Although saffron is a sterile, vegetatively propagated crop, local germplasm has significant morphological and agronomic heterogeneity (Iqbal *et al.,* 2023; Fazil *et al.,* 2024), which may impact divergent responses to weed competition. However, there is little information available on the comparative performance of saffron genotypes in weed-free and weedy environments. A better understanding of how germplasm lines respond to weed interference could aid in the identification of lines with more consistent performance in low-input or heavily infested environments. In the present study, 35 saffron germplasm lines were evaluated under two contrasting weed regimes to quantify the impact of weed pressure on key floral, vegetative, and corm traits, assess variability in genotypic performance across weed-free and weedy environments, and identify lines exhibiting stable phenotypic expression under differing levels of weed interference. While the study does not aim to establish genetic weed tolerance, it provides a preliminary understanding of genotypic responsiveness to weed competition in temperate saffron agro-ecosystems.

MATERIALS AND METHODS

Experimental site: The experiment was carried out at the Advanced Research Station for Saffron & Temperate Seed Spice, Konibal, Pampore, Sher-e-Kashmir University of Agricultural Sciences and Technology, Kashmir, during the saffron-growing season. The location is 1574 meters above sea level and is located at 34°01′N, 74°56′E. The pH of the soil was 6.90, it was silty clay, and its organic carbon content was medium (0.81%). Nutrient status was 276 kg N/ha, 26 kg P/ha, and 312 kg K/ha. The region falls within the temperate agro-climatic zone of Kashmir Valley, characterised by cool winters, mild summers, and moderate rainfall.

Plant material: 35 saffron (*Crocus sativus* L.) germplasm lines, designated G1–G35, have been collected from farmers' fields throughout Jammu and Kashmir's traditional saffron-growing areas were used in the study (Annexure-1). These germplasm lines are clonal selections that have been preserved over years in their respective regions because saffron is a sterile, vegetatively propagated crop. As a result, there is no "control variety," and each line was assessed in relation to the other under the two weed regimes.

Experimental design and treatments: A split-plot design with three replications was used. The factors included: Main plot: W1: Weed-free, maintained by regular hand-weeding at critical stages, W2: Weedy, where plots were left unmanaged to allow natural weed infestation Sub-plots: 35 saffron germplasm lines (G1–G35). Each subplot measured 1.0 m × 1.0 m, and corms were planted at 20 cm × 10 cm spacing with uniform depth and orientation.

Crop establishment and management: Field preparation involved cross-ploughing followed by disc harrowing to break soil clods, and final levelling using a power tiller. The nutrient management consisted of:FYM: 15 t/ha incorporated at final land preparation;Vermicompost: 5 q/ha;Basal fertilizers**:** 90 kg N + 60 kg P_2O_5 + 50 kg K_2O/ha (Naseer *et al.,* 2018).The remaining 60 kg N/ha was applied in two equal splits during December and February when soil moisture was available . All plots received uniform irrigation, nutrient application, and plant protection measures.

Observations recorded: Data were recorded at appropriate phenological stages using standard procedures:

- *Fresh pistil weight (mg):* Five freshly collected pistils per plot were weighed using a precision electronic balance.
- *Dry pistil weight (mg):* The same pistils were oven-dried at 45–50°C to constant weight.
- *Pistil, stigma, and style lengths (cm):* Measured using a digital caliper on five flowers per plot.
- *Outer and inner tepal length and width (cm):* Measured on five randomly collected fresh flowers per subplot. Length was measured from base to tip; width at the widest point.
- *Number of leaves per plant:* Recorded from five randomly selected plants per subplot.
- *Leaf length (cm):* Measured from base to tip using a measuring scale on the same plants.
- *Corm diameter (cm):* Measured using a digital Vernier caliper on five harvested corms.

For all traits, the values from five observations were averaged per subplot before statistical analysis. Data were analysed using analysis of variance (ANOVA) appropriate for a split-plot design using R software. Treatment means were compared using Least Significant Difference (LSD) at $p \leq 0.05$. To understand trait interrelationships: Pearson's correlation coefficients were computed for floral, vegetative, and corm traits: Correlations were also examined separately for weed-free and weedy conditions to assess trait stability and response under differential weed pressure.

RESULTS AND DISCUSSION

The results of the experiment revealed that the presence of weeds in saffron crop had a huge impact on floral as well as vegetative growth and development of the saffron. The various weeds which were found in the saffron experimental plots during the study are as shown in Fig. 1 & Table-1. The effect of the different treatments on saffron is presented as follows:

Common poppy Shepherds purse Wild tulip

Fig. 1: Major weeds found in experimental plots during the investigation

Table 1: Major weeds found in experimental plots during the study

S. No.	Common name of weed	Scientific name of weed
1.	Creeping speed well	*Veronica filiformis* L.
2.	Sticky plant	*Galium aparine* L.
3.	Field bind weed	*Convolvulus arvensis* L.
4.	Common poppy	*papaver rhoeas* L.
5.	Shepherds purse	*Capsella bursa pastoris* L.
6.	Wild tulip	*Tulipa stellate L.*

Effect of weed regimes and germplasm lines on vegetative, floral and corm traits of saffron: Weed regimes, germplasm lines, and their interaction had significant effect on fresh pistil weight (Table 2). Fresh pistil weight was higher in weed-free plots (47.82 mg) than in weedy plots (42.04 mg). This decrease under weed pressure is attributed to competition for light, moisture, and nutrients, which inhibits the growth of flowers. Ahmadi and Omidbaigi (2000) reported similar results, noting increased pistil and stigma biomass in weed-free environments. The maximum fresh pistil weight was obtained by germplasm lines G24, G31, and G8. The significant W × G interaction showed that W1:G24 expressed the maximum fresh pistil weight, indicating superior performance under optimal conditions. Similar trends were seen in the dry pistil weight, with weedy plots recording 8.71 mg and weed-free plots recording 10.68 mg (Table 2). The interaction was not significant, however, suggests that this characteristic is stable across weed regimes. Previous studies by Fernández (2004) and Nehvi *et al.* (2011) similarly emphasised the impact of environmental factors and genotypic variation on pistil biomass. Under weed pressure, pistil length decreased sharply (W1 = 4.28 cm; W2 = 3.50 cm) as presented in Table 2. The longest pistil was found in germplasm line G4. Ali *et al.* (2014) also found that weed-free conditions improve assimilate partitioning to reproductive organs in saffron germplasm. Under weedy conditions, style length decreased significantly (W1 = 2.23 cm; W2 = 1.66 cm) (Table 2). Better style length was shown by genotypes G9 and G4. However, there was no significant difference in stigma length between weed regimes, suggesting genetic control. The longest stigmas were found in germplasm lines G16 and G4. The results of Fernández (2004) and Ali *et al.* (2014), who found that stigma length is a crucial yield-contributing trait and primarily genotype-driven, are consistent with the significant genotype dependency of stigma features. In weedy environments, all tepal characteristics-outer tepal length, inner tepal length, and widths—were greatly reduced (Table 2). Tepal characteristics, such as outer tepal length (W1 = 3.65 cm, W2 = 2.90 cm), were larger in weed-free plots. The maximum tepal size was consistently shown by genotype G4. Gresta *et al.* (2008), who proposed that well-developed tepals reflect floral vitality and are positively linked with stigma yield, corroborate these findings. Additionally, Ali *et al.* (2014) found moderate associations between reproductive characteristics and tepal shape. Weed regimes and germplasm lines had a considerable impact on vegetative characteristics. Under weed-free conditions, leaf number and length of leaves were significantly greater (29.20 and 32.44 cm) than in weedy conditions (20.34 and 21.83 cm). Superior vegetative growth was observed in germplasm lines G2, G4, and G22. Singh *et al.* (2012) and Sharma *et al.* (2024b) showed similar inhibition of vegetative development under weed pressure, indicating that weeds lower soil moisture and nutrient availability during crucial stages of saffron growth. The physiological functions outlined by Worthington & Reberg-Horton (2013) are also consistent with increased vegetative vigour in weed-free environments. In the absence of weeds, corm diameter was significantly higher as compared to weedy plots. The higher corm diameter were found with germplasm lines; G24, G31, and G4. These findings are consistent with those of Ahmadi and Omidbaigi (2000), Nehvi *et al.* (2011) & Hussain *et al,* (2019) who found that greater nutrient and moisture availability in weed-free plots promotes better subsurface biomass accumulation. The decreased corm characteristics under weedy conditions can be explained by the fact that weeds restrict corm growth by intercepting resources during the dormancy–sprouting transition (Galavi *et al.,* 2008).

Correlation analysis:

<u>Interrelationships among floral yield components:</u> Strong and significant relationships were found between fresh pistil weight and dry pistil weight (r = 0.744***), pistil length (r = 0.661***), and stigma length (r = 0.704***). Additionally, tepal characteristics showed relatively positive correlations (Fig. 2). These findings are consistent with previous research by Fernández (2004), who reported pistil and stigma morphology as key factors influencing production, and Ali *et al.* (2014), who found significant connections between stigma length, pistil weight, and total saffron yield.

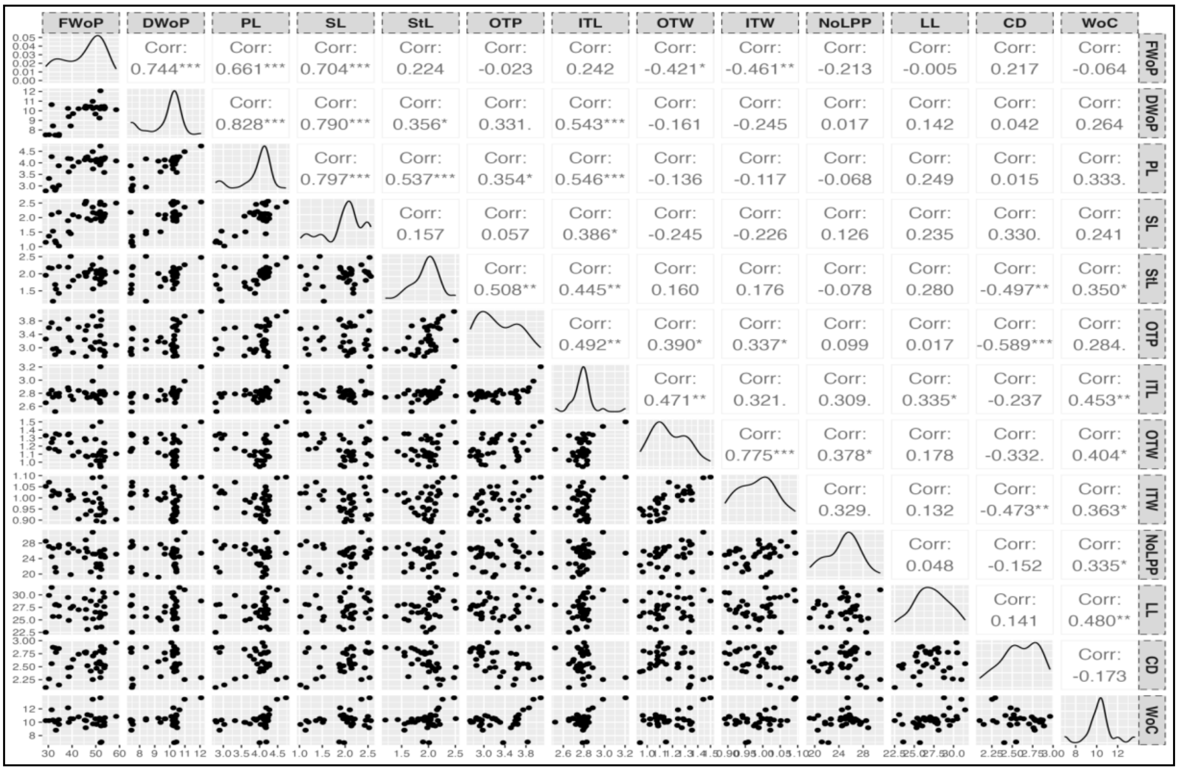

Fig. 2: Correlation coefficients among floral and yield-contributing traits in saffron germplasm lines

<u>Comparative correlation of traits under weed-free and weedy environments:</u> Compared to vegetative features, floral qualities exhibited more stable trait correlations. A strong cross-regime correlation (r = 0.917) was found in fresh pistil weight, suggesting that high-performing genotypes under W1 typically retained rank under W2. While corm weight showed a weak cross-regime correlation (r = 0.28), vegetative parameters like leaf number shown moderate stability (r = 0.40). Similarly, Mir et al. (2025) found that vegetative and physiological characteristics experience more variability in weed-infested plots (Fig. 3).

<u>Correlation of fresh weight of pistil with morphological and floral traits:</u> Fresh pistil weight correlated strongly with pistil dry weight and floral elongation features, indicating that larger, well-developed floral organs contribute directly to pistil biomass. Vegetative traits demonstrated weaker correlations, revealing that floral traits are more reliable predictors of pistil weight under differing weed pressures (Fig. 4). These findings are consistent with the importance of floral morphology described by Gresta *et al.* (2008).

Table 2: Effect of weed regimes and saffron germplasm lines on growth and yield traits of saffron (*Crocus sativus* L.)

Treatment	Fresh weight of pistil (mg)	Dry weight of pistil (mg)	Pistil length (cm)	Stigma length (cm)	Style length (cm)	Outer tepal length (cm)	Inner tepal length (cm)	Outer tepal width (cm)	Inner tepal width (cm)	No. of leaves per plant	Leaf length (cm)	Corm diameter (cm)
Weed regimes												
Weed free	47.82^{a}	10.68^{a}	4.28^{a}	2.14^{a}	2.23a	3.65^{a}	3.15^{a}	1.33^{a}	1.13^{a}	29.20^{a}	32.44^{a}	2.64^{a}
Weedy	42.04^{b}	8.71^{b}	3.50^{b}	1.81^{b}	1.66^{b}	2.90^{b}	2.42^{b}	1.02^{b}	0.84^{b}	20.34^{b}	21.83^{b}	2.54^{b}
LSD ($p \leq 0.05$)	**3.32**	**0.84**	**0.09**	**0.20**	**0.17**	**0.15**	**0.19**	**1.10**	**0.09**	**3.92**	**3.75**	**0.09**
Germplasm lines												
G1	28.90^{p}	7.48^{h}	2.78^{m}	1.15^{l}	1.95^{ghij}	3.26^{ghi}	2.65^{de}	1.33^{cd}	1.05^{abcd}	28.50^{abc}	22.51^{m}	2.10^{o}
G2	48.69^{fghij}	10.97^{a}	4.48^{ab}	2.35^{bc}	2.26^{b}	3.94^{ab}	2.98^{b}	1.44^{ab}	1.09^{ab}	30.83^{a}	31.00^{ab}	2.25^{n}
G3	34.46^{n}	7.54^{h}	3.02^{lm}	1.02^{l}	2.21^{bc}	3.56^{e}	2.80^{bcd}	1.34^{bcd}	1.02^{abcdefgh}	27.50^{abcd}	25.66^{ghijklm}	2.15^{o}
G4	51.94^{bcdef}	12.07^{a}	4.73^{a}	2.53^{ab}	2.47^{a}	4.08^{a}	3.20^{a}	1.50^{a}	1.09^{a}	25.41^{bcdefg}	28.78^{abcdefgh}	2.29^{n}
G5	30.27^{op}	7.50^{h}	3.32^{kl}	1.36^{jk}	2.17^{bcde}	3.60^{de}	2.79^{bcd}	1.17^{efgh}	1.07^{abc}	27.16^{abcd}	29.90^{abcd}	2.26^{n}
G6	38.62^{m}	9.38^{ef}	3.61^{ijk}	1.51^{j}	1.62^{mn}	3.30^{gh}	2.84^{bcd}	1.35^{bc}	0.99^{cdefghijkl}	27.70^{abcd}	24.90^{ijklm}	2.30^{n}
G7	38.31^{m}	10.23^{bcd}	4.18^{bcde}	1.89^{hi}	2.19^{bcd}	3.85^{bc}	2.88^{bc}	1.34^{cd}	1.03^{abcdef}	25.50^{abcd}	29.46^{abcdef}	2.48^{klm}
G8	53.58^{bc}	10.19^{bcde}	4.16^{cdef}	2.43^{ab}	2.08^{cdefg}	3.11^{ijkl}	2.77^{cd}	1.23^{defg}	1.05^{abcde}	25.60^{cdefgh}	29.52^{abcde}	2.47^{klm}
G9	39.42^{lm}	8.42^{g}	4.17^{cdef}	1.44^{j}	2.50^{a}	3.21^{ghij}	2.76^{cd}	1.24^{def}	1.01^{abcdefghi}	19.85^{j}	27.32^{bcdefghij}	2.48^{klm}
G10	45.38^{jk}	10.28^{bcd}	4.13^{cdefg}	2.46a^{b}	2.03^{defghi}	3.24^{ghi}	2.81^{bcd}	1.29^{cd}	1.01^{abcdefgh}	24.23^{defghi}	29.27^{abcdefg}	2.77^{defg}
G11	40.39^{lm}	9.70^{def}	3.84^{ghij}	2.09^{defgh}	1.80^{jkl}	2.85^{opq}	2.70^{cde}	1.08^{hijk}	1.00^{abcdefghij}	26.66^{bcd}	27.71^{bcdefghi}	2.64^{hi}
G12	34.38^{n}	7.40^{h}	3.87^{efghij}	2.18^{cde}	1.43^{o}	2.89^{nopq}	2.74^{cd}	1.13^{hi}	1.01^{hijk}	26.91^{abcd}	27.84^{abcdefghi}	2.85^{bcde}
G13	31.95^{nop}	8.42^{g}	2.95^{m}	1.53^{j}	1.19^{p}	2.96^{mno}	2.73^{cd}	1.29^{cd}	1.03^{ghi}	26.66^{bcd}	25.67^{ghijklm}	2.87^{abc}
G14	33.21^{no}	7.45^{h}	2.89^{m}	1.13^{l}	1.55^{no}	2.97^{lmno}	2.79^{bcd}	1.35b^{c}	1.02^{abcdefg}	21.71^{ij}	28.10^{abcdefghi}	2.77^{defg}
G15	32.88^{no}	7.46^{h}	2.81^{m}	1.20^{kl}	1.68^{lmn}	2.79^{pq}	2.52^{e}	1.16^{fghi}	0.95^{efghijklm}	20.50^{ghij}	28.00^{abcdefghi}	2.86^{bcd}
G16	45.88^{ijk}	10.24^{bcd}	4.23^{bcd}	2.56^{a}	1.92^{ghij}	2.74^{q}	2.80^{bcd}	1.07^{hijk}	0.92^{hijklm}	26.66^{bcd}	27.06^{cdefghijk}	2.78^{cdefg}

Table 2 continued

G17	53.55^{bc}	10.45^{bcd}	3.58^{jk}	2.04^{defghi}	1.74^{klm}	2.75^{q}	2.77^{cd}	1.14^{ghi}	0.93^{ghijklm}	26.33^{bcde}	27.64^{bcdefghi}	2.83^{bcde}
G18	51.77^{bcdef}	10.19^{bcde}	3.90^{efghi}	2.45^{ab}	1.80^{jkl}	2.95^{mno}	2.82^{bcd}	0.97^{lm}	0.92^{ijklm}	25.91^{bcdef}	26.42^{defghijkl}	2.80^{bcdef}
G19	48.83^{efghi}	10.21^{bcde}	3.73^{hij}	2.17^{cde}	1.55^{no}	2.95^{mno}	2.79^{bcd}	1.08^{hijk}	0.98^{cdefghijklm}	25.20^{bcdefg}	25.17^{hijklm}	2.70^{gh}
G20	42.75^{kl}	10.20^{bcde}	4.03^{cdefgh}	2.03^{defghi}	1.93^{ghij}	3.61^{de}	2.84^{bcd}	1.12^{hij}	0.90^{jklm}	25.91^{bcdef}	27.03^{cdefghijk}	2.74^{fg}
G21	52.22^{bcde}	10.28^{bcd}	4.14^{cdefg}	2.13^{def}	2.12^{bcdf}	2.92^{nop}	2.82^{bcd}	1.08^{hijk}	0.97^{cdefghijklm}	24.50^{defgh}	26.01^{efghijklm}	2.88^{ab}
G22	31.39^{nop}	10.63^{bc}	4.26^{bc}	2.10^{defg}	2.16^{bcde}	3.74^{cd}	2.84^{bcd}	1.24^{def}	1.01^{abcdefghi}	24.50^{defgh}	31.48^{a}	2.55^{ijkl}
G23	49.84^{defgh}	9.66^{def}	4.12^{cdefg}	1.96^{fghi}	1.87^{ijk}	3.16^{hijk}	2.77^{cd}	1.28^{cd}	1.02^{abcdefg}	25.16^{bcdefg}	26.53^{defghijkl}	2.76^{efg}
G24	58.58^{a}	10.10^{cde}	4.08^{cdefg}	2.49^{ab}	2.05^{cdefgh}	3.07^{jklm}	2.80^{bcd}	1.10^{hijk}	0.90^{klm}	25.16^{bcdefg}	30.38^{abc}	2.96^{a}
G25	53.19^{bcd}	10.22^{bcde}	4.13^{cdefg}	1.99^{efghi}	2.03^{defgh}	2.91^{nop}	2.83^{bcd}	1.02^{klm}	0.89^{m}	24.91^{bcdefgh}	30.46^{abc}	2.76^{efg}
G26	45.75^{ijk}	10.4^{8bcd}	4.17^{bcdef}	2.52^{ab}	1.98^{fghi}	3.51^{ef}	2.80^{bcd}	1.27^{cde}	0.98^{cdefghijkl}	28.83^{abbcdefgh}	25.30^{hijklm}	2.76^{efg}
G27	51.54^{bcdef}	9.24^{fg}	4.07^{cdefg}	2.10^{defg}	2.00^{efghi}	3.18^{hij}	2.69^{cde}	1.11^{hijk}	0.99^{bcdefghijk}	19.19^{j}	25.39^{hijklm}	2.59^{ij}
G28	51.84^{bcdef}	10.34^{bcd}	3.93^{defgh}	2.21^{cd}	1.69^{lmn}	3.65^{de}	2.65^{de}	1.02^{jklm}	0.95^{efghijklm}	22.66^{efghij}	26.50^{defghijkl}	2.55^{ijkl}
G29	50.31^{cdefg}	10.37^{bcd}	4.15^{cdefg}	2.13^{def}	2.00^{efghi}	3.64^{de}	2.76^{cd}	1.08^{hijk}	0.89^{lm}	21.72^{ghij}	27.93^{abcdefghi}	2.56ijk
G30	52.34^{bcd}	10.43^{bcd}	4.18^{bcde}	1.87^{i}	1.89^{hijk}	3.83^{bc}	2.82^{bcd}	1.15fghi	0.95^{defghijklm}	21.16^{hij}	23.60^{jklm}	2.54^{jkl}
G31	53.81^{b}	10.33^{bcd}	4.22^{bcd}	2.13^{def}	1.98^{fghi}	2.86^{opq}	2.79^{bcd}	1.06^{ijkl}	0.94^{fghijklm}	22.25^{defghi}	26.21^{defghijklm}	2.52^{jkl}
G32	51.98^{bcdef}	10.29^{bcd}	4.00^{cdefgh}	1.97^{efghi}	2.01^{efghi}	3.36^{fg}	2.78^{cd}	0.94^{m}	0.95^{fghijklm}	24.33^{fghij}	25.71^{fghijklm}	2.40^{m}
G33	47.89^{ghij}	10.43^{bcd}	4.10^{cdefg}	1.90^{ghi}	2.13^{bcdf}	3.02^{klmn}	2.74^{cd}	0.96^{lm}	0.94^{fghijklm}	20.50^{ij}	28.75^{abcdefgh}	2.41^{m}
G34	46.47^{hij}	10.42^{bcd}	4.26^{bc}	1.96^{fghi}	2.04^{defgh}	3.66^{de}	2.73^{cd}	1.06^{ijkl}	0.99^{cdefghijkl}	25.74^{bcdef}	23.08^{lm}	2.51^{jkl}
G35	50.31^{cdefg}	10.36^{bcd}	4.03^{cdefgh}	2.14^{def}	2.08^{cdefg}	3.64^{de}	2.72^{cd}	1.02^{klm}	0.92^{ijklm}	22.66^{efghij}	22.48^{klm}	2.46l^{m}
LSD ($p \leq 0.05$)	**4.87**	**1.19**	**0.43**	**0.29**	**0.24**	**0.21**	**0.27**	**0.15**	**0.13**	**5.54**	**5.30**	**0.13**

Means followed by different letters indicate significance ($p \leq 0.05$) among treatments

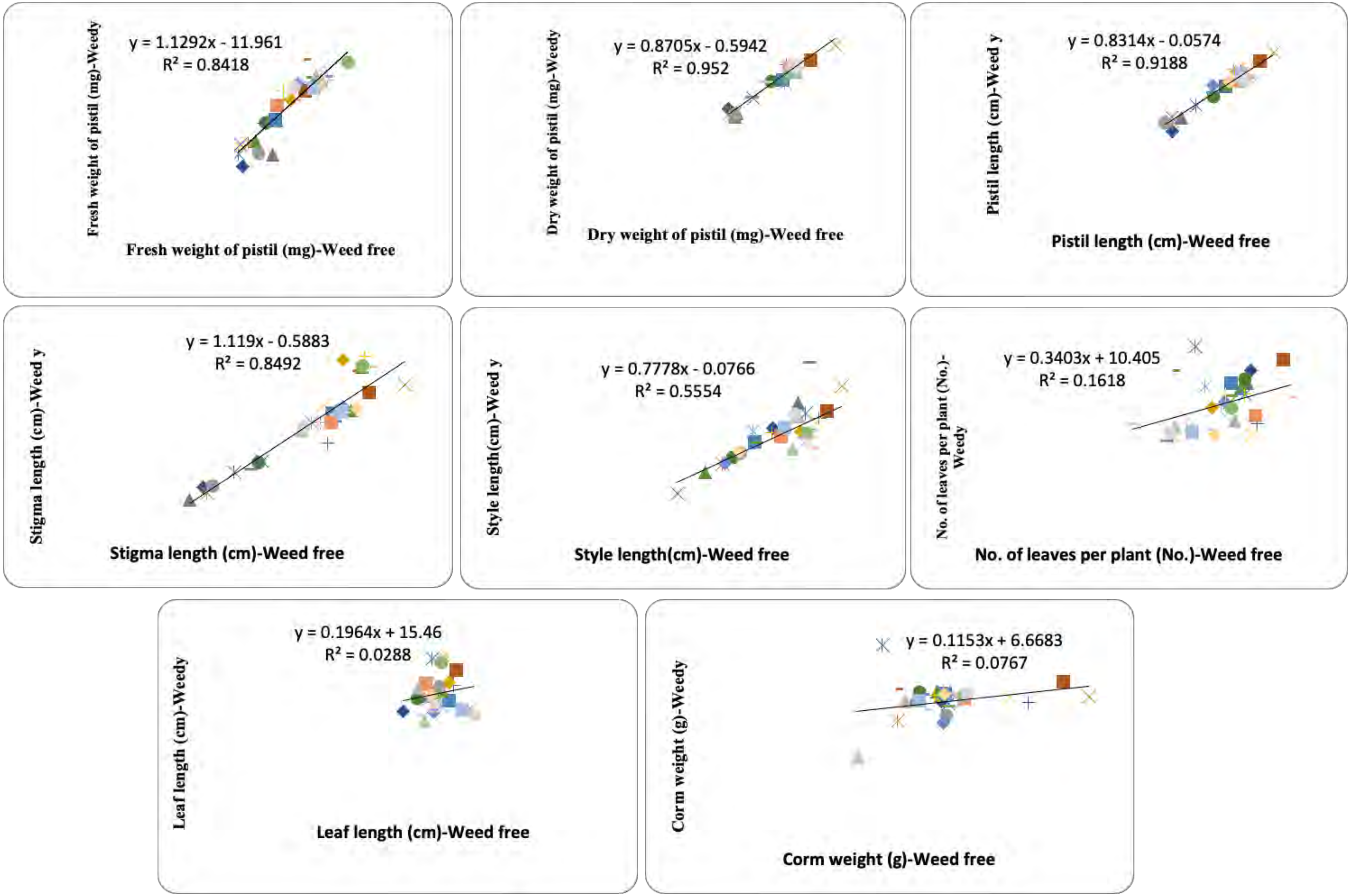
y = 1.1292x - 11.961
R² = 0.8418
Fresh weight of pistil (mg)-Weedy
Fresh weight of pistil (mg)-Weed free
y = 0.8705x - 0.5942
R² = 0.952
Dry weight of pistil (mg)-Weedy
Dry weight of pistil (mg)-Weed free
y = 0.8314x - 0.0574
R² = 0.9188
Pistil length (cm)-Weed y
Pistil length (cm)-Weed free
y = 1.119x - 0.5883
R² = 0.8492
Stigma length (cm)-Weed y
Stigma length (cm)-Weed free
y = 0.7778x - 0.0766
R² = 0.5554
Style length(cm)-Weed y
Style length(cm)-Weed free
y = 0.3403x + 10.405
R² = 0.1618
No. of leaves per plant (No.)-Weedy
No. of leaves per plant (No.)-Weed free
y = 0.1964x + 15.46
R² = 0.0288
Leaf length (cm)-Weedy
Leaf length (cm)-Weed free
y = 0.1153x + 6.6683
R² = 0.0767
Corm weight (g)-Weedy
Corm weight (g)-Weed free

Fig. 3: Correlation of selected traits under weed-free and weedy conditions in saffron genotypes

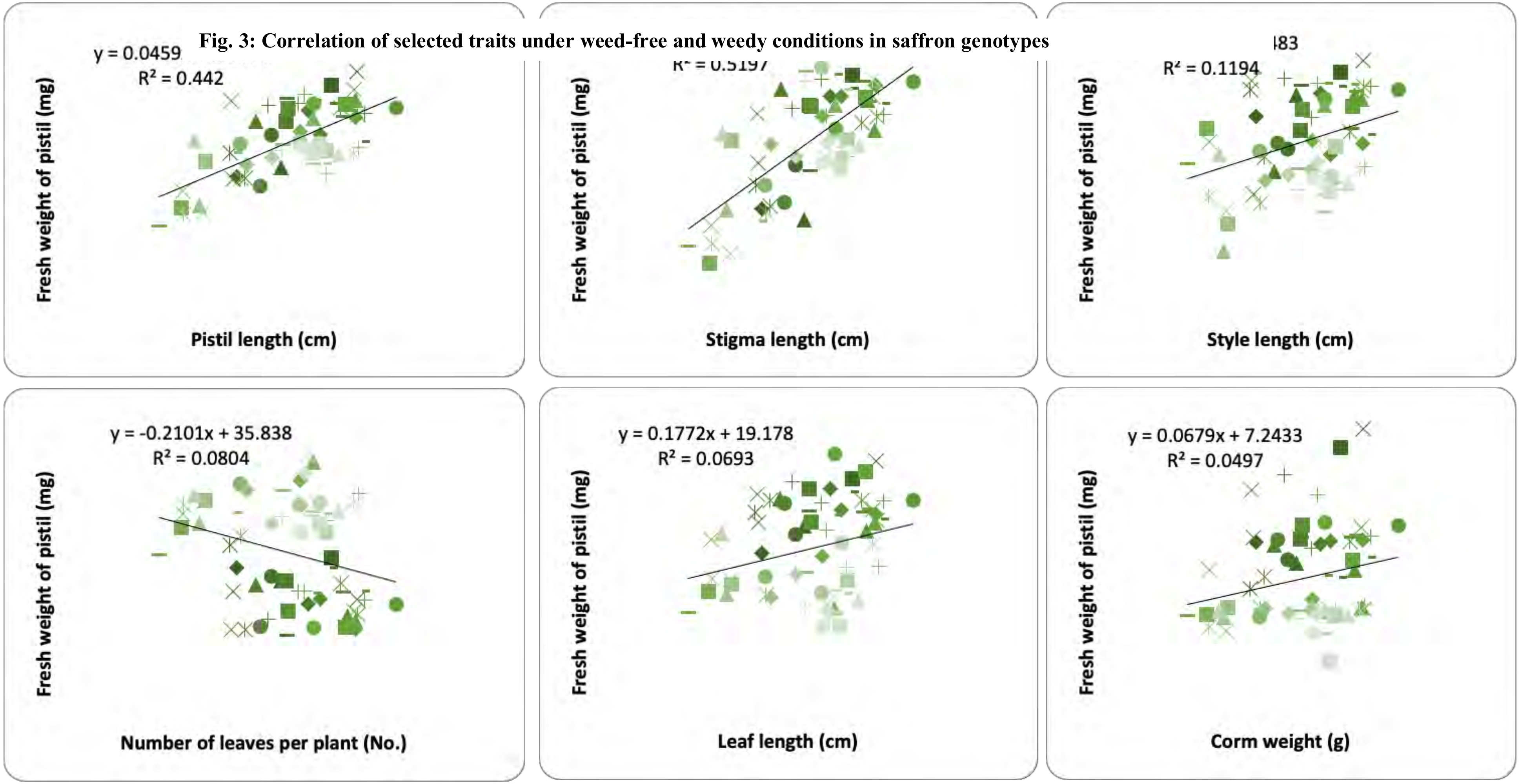

Fig. 4: Trait-wise correlations with fresh weight of pistil in saffron germplasm lines

Annexure-1 Detailed list of saffron germplasm lines and their collection sites

S. No.	Germplasm Line	Source	Place of collection
1.	G1	Farmers' field	Shar, Pampore, District Pulwama
2.	G2	Farmers' field	Lethipora, Pampore, District Pulwama
3.	G3	Farmers' field	Dussu, Pampore, District Pulwama
4.	G4	Farmers' field	Chandhara, Pampore, District Pulwama
5.	G5	Farmers' field	Wuyan, Pampore, District Pulwama
6.	G6	Farmers' field	Nambal bal, Pampore, District Pulwama
7.	G7	Farmers' field	Patal bagh, Pampore, District Pulwama
8.	G8	Farmers' field	Kishtwar
9.	G9	Farmers' field	Khrew, Pampore, District Pulwama
10.	G10	Farmers' field	Gundbal, Pampore, District Pulwama
11.	G11	Farmers' field	Gundbal, Pampore, District Pulwama
12.	G12	Farmers' field	Gundbal, Pampore, District Pulwama
13.	G13	Farmers' field	Sombur, Pampore, District Pulwama
14.	G14	Farmers' field	Sombur, Pampore, District Pulwama
15.	G15	Farmers' field	Dussu, Pampore, District Pulwama
16.	G16	Farmers' field	Ladhoo, Pampore, District Pulwama
17.	G17	Farmers' field	Ladhoo, Pampore, District Pulwama
18.	G18	Farmers' field	Munpora, Pampore, District Pulwama
19.	G19	Farmers' field	Munpora, Pampore, District Pulwama
20.	G20	Farmers' field	Chandhara, Pampore, District Pulwama
21.	G21	Farmers' field	Chandhara, Pampore, District Pulwama
22.	G22	Farmers' field	Patal bagh, Pampore, District Pulwama
23.	G23	Farmers' field	Wuyan, Pampore, District Pulwama
24.	G24	Farmers' field	Wuyan, Pampore, District Pulwama
25.	G25	Farmers' field	Wuyan, Pampore, District Pulwama
26.	G26	Farmers' field	Wuyan, Pampore, District Pulwama
27.	G27	Farmers' field	Wuyan, Pampore, District Pulwama
28.	G28	Farmers' field	Wuyan, Pampore, District Pulwama
29.	G29	Farmers' field	Shar, Pampore, District Pulwama
30.	G30	Farmers' field	Shar, Pampore, District Pulwama
31.	G31	Farmers' field	Munpora, Pampore, District Pulwama
32.	G32	Farmers' field	Munpora, Pampore, District Pulwama
33.	G33	Farmers' field	Kishtwar
34.	G34	Farmers' field	Kishtwar
35.	G35	Research Field	SKUAST-K

CONCLUSION

Weed pressure significantly reduced floral, vegetative, and corm characteristics of saffron, demonstrating the importance of timely weed control for improving yield. Among the 35 germplasm lines, G24, G4, and G31 showed consistently higher performance across both weed regimes, indicating phenotypic superiority rather than verified weed tolerance. Compared to vegetative characteristics floral traits showed more stability and stronger correlations with pistil yield. Overall, the study provides useful baseline information for selecting better-performing lines and improving weed management strategies in saffron.

CONFLIT OF INTEREST

All the authors affirm that there is no conflict of interest among them. All research activities comply with relevant legal, institutional and ethical standards.

AUTHOR CONTRIBUTION

All the authors contributed equally in the present study.

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