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Original Article

IN VITRO STUDIES ON EFFECT OF CORM WEIGHT AND AVAILABILITY OF MOISTURE ON PLANT DEVELOPMENT IN SAFFRON (*Crocus sativus* L.)

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Abstract: Significant impact of corm weight was observed on enhancing number of sprouts located in apicular, sub apicular and auxiliary regions. Increased number of sprouts particularly in sub-apicular and auxiliary region was observed to be detrimental for induction of more number of productive flowering sprouts and exhibited significant relationship with increased number of vegetative nonproductive sprouts. 1-3 flowers/sprout were recorded from apicular regions in corms weighing above 8 g whereas, sub-apicular regions showed maximum 1-2 flowers/spathe. Corms weighing below 7 g exhibited only vegetative sprouts, thereby, confirming importance of corm weight on flower induction. Number of leaves/corm ranged from, 2.0 (1-2g) - 21.9(>15 g) with maximum contribution of sprouts in apicular region (2-10.6) followed by sub-apicular (2-7.3) and auxiliary sprouts (1.6-4). Similar positive effects of corm weight and moisture availability was observed on root development and cataphyll length. Maximum number of lateral/terminal contractile roots (5.9) were observed in corms weighing above 15 g with adequate moisture followed by 4.3 in corms weighing 8-14 g, whereas, in other category of corms weighing less than 7 g only 2 contractile roots were observed, thereby, confirming that heavier corms confirm to better potential of daughter corm production. Available moisture was found to be a critical factor for cataphyll length and root development irrespective of corm weight but proportionate increase was more in bigger corms rather than smaller corms.

Key words: Saffron (*Crocus sativus* L), Corm weight

INTRODUCTION

The corm is vegetative organ of saffron and enters a dormant stage from May till 25th June. Although important ontogenic process that leads to differentiation of vegetative buds takes place but, nothing is observed externally [1]. During dormancy, there is a decrease in starch concentration in the corms. Starch is converted into sucrose and other suitable soluble sugars which go to tissues where buds are being differentiated and developed [2]. However, activation initiates around 15thJuly with development of leaf primordial, followed by bract development around last week of July. As a consequence of hyseteranthy flower development with a first whorl of tepal with gynoecium reaching one half length of the stamens is completed around 3rd week of August [3]. Corms begin to sprout with floral and vegetative structures increasing in length inside the cataphylls, however the number of sprouts is directly proportional to corm size. In earlier studies we have investigations the genetic variability using induced mutation and *in vitro* microcorm formation in saffron [4,5], in present re-evaluation the impact of corm weight and available moisture on plant development in saffron has been explored.

MATERIAL AND METHODS

In vitro studies on effect of corm weight and available moisture on plant development was carried out at Saffron Research Station. 2500 corms of 5 different weights replicated five times (>15g,8-14 g,5-7g, 3-5 g ,1-2 g) were collected from Natural sub-Populations of Kashmir during August 2012 and 2013 and were studied for plant development using sand medium in trays of 1.5 m^2 area under controlled *in vitro* conditions with maximum temperature around 25^0 C and minimum temperature 15^0C from 15^{th} August to 15^{th} October followed by 17^0C maximum temperature and 10^0 C minimum temperature from 16^{th} October to 15^{th} November under white fluorescent light of 42 ìmol/m^2s1 with the photoperiod of 16 h light and 8 h dark. Sterile condition of sand media were ensured by spraying fungicidal solution (Mancozeb@0.3% and Carbendizime 0.01%) at weekly intervals to avoid fungal contamination [6]. Plant development viz a viz number of leaves, average cataphyll length and root development was studied under moisture stress and adequate moisture. Each tray of 1.5 m^2 was supplemented with 0.003 m^3 of water on alternate days over a period of 90 days (15^{th} August to 15^{th} November).

Mean values over a period of two years for plant development traits viz; average sprout number, average number of flowering sprouts , average number of vegetative sprouts, cataphyll width (cm), average cataphyll length for leaf emergence (cm), average number of leaves/sprout, average number of flowers/sprout, number of adventitious roots and number of contractile roots were subjected to analysis of variance.

RESULTS AND DISCUSSION

Analysis of variance revealed significant difference for all the traits studied suggesting importance of corm weight on plant development. Similar impact of corm weight was also reported by several workers [7-9]. Components of phenotypic variability (Table-1) indicated that a wide range of variability existed for average number of sprouts (1.0-10.5), average number of flowering sprouts (0-3), average number of flowers/sprout (0-3),a verage number of leaves (2.0-21.9), cataphyll width (0.3-1.1), average cataphyll length – moisture stress (0-4.5), average cataphyll length – adequate moisture (3.5-15.6), average number of contractile roots-moisture stress (2.0-9.0), average number of contractile roots and adequate moisture (7.0-15.3). The estimates of phenotypic variance were slightly higher than the corresponding estimates of genotypic variance thereby revealing influence of environment in the expression of the traits studied. To assess the nature of genetic variability, phenotypic and genotypic coefficient of variation were also estimated. Higher genotypic coefficient of variation was recorded for all the characters studied. Heritability in broad sense was observed to be high for all traits in both the years. Expected genetic gain (as % of mean) was observed to be high for all the traits. The study suggests that there is an ample scope for saffron improvement through selection of heavier corms from the heterogeneous saffron populations of Kashmir.

The number of macro and micro meristematic scar like buds covered by tunics found in internodes varied from 2 to 20 depending on the corm weight which significantly influenced number of sprouts located in apicular (1-1.5), sub apicular (0-6) and Auxiliary regions(0-3).On an average maximum sprout number (10.5) was observed from corms weighing >15 g followed by 8-14 g(8.6), 5-7g (5.3), 3-5 g (2) and 1-2 g corms(1). As the corm weight increases apicular, sub apicular and auxiliary buds tend to group together, so that, majority can be found in one, two or three internodes. Similar findings have also been reported by Perez, [10]. More number of flowering sprouts is imperative for high saffron productivity. Study confirmed that increased number of sprouts particularly in subapicular and auxiliary region was negatively correlated with flowering sprouts and exhibited strong relationship with increased number of vegetative sprouts. Corms weighing > 8 g exhibited flowering sprouts ranging from 1-3 with 100% flowering from apicular buds followed by 25.86% flowering in sub apicular and 0% flowering in auxiliary sprouts, respectively. Number of flowers per spathe ranged from 1-3 with maximum flowers (3) from corms weighing >15 g. Increased number of flowers/spathe was associated with more cataphyll width (1.0 to 1.1 cm) as compared to 0.3 to 0.7 cm cataphyll width of non-flowering vegetative sprouts present in sub apicular and auxiliary meristemtic regions. Corms weighing <7.0 g exhibited 100% vegetative sprouts ranging


>15 g
8-14g
<7 g
Effect of Corm Weight on Sprout Number
FLOWERS/SPATHE
Effect of Corm Weight on Plant Development
Effect of Corm Weight on Number of Flowers/sprout

Table I: Components of variability for plant development traits in saffron-Averaged over years

Components of Variation	Average Number of Sprouts	Average Number of Flowering Sprouts	Average Number of Flowers/ Sprout	Average Number of Leaves	Cataphyll Width	Average Cataphyll length		Average Number of Contractile Roots	
						Moisture Stress	Adequate Moisture	Moisture Stress	Adequate Moisture
Mean	5.48 ±0.11	0.496 ±0.052	0.80 ±0.09	12.24 ±0.087	0.72 ±0.10	2.21 ±0.107	6.88 ±077	4.572 ±0.069	9.21 ±0.083
Range	1.0-10.5	0-3	0-3	2.0-21.9	0.3-1.1	0-4.5	3.5-15.6	2.0-9.0	7.0-15.3
6^2e	0.81	0.017	0.21	0.047	0.23	0.07	0.037	0.02	0.043
6^2 p	17.281	0.504	0.51	73.88	0.64	1.24	21.51	8.78	12.30
6^2 g	17.200	0.486	0.50	73.83	0.63	1.17	21.48	8.75	12.26
ECV	5.20	26.59	21.0	1.78	22.51	12.09	2.80	3.77	0.515
GCV	75.68	140.63	106.10	70.15	135.12	49.01	67.32	64.72	38.03
PCV	75.86	143.13	110.20	70.17	136.20	50.48	67.38	64.83	38.09
Genetic Advance	8.52	1.41	2.67	17.69	1.53	2.16	9.53	6.08	7.20
Genetic Gain as % of mean	155.53	284.6	167.5	144.41	275.2	98.02	138.56	133.11	78.20
Heritability	0.99	0.965	0.99	0.99	0.99	0.94	0.99	0.99	0.99

Table 2: Effect of corm weight on sprout number- Averaged over years

Corm Weight	Average Number of Sprout			Total	Average Number of Flowering Sprouts	% Contribution	Total Number of vegetative non flowering Sprouts	% Contribution	Number of Flowers/ sprout
	Apical	Sub apical	Auxiliary						
>15g	1.5	6	3	10.5	2.5	23.80	8.0	76.19	2.5
8-14g	1	5.6	2	8.6	1.5	17.44	7.1	82.55	1.5
5-7g	1	3.3	1	5.3	0	0	5.3	100.0	0
3-5g	1	1	0	2	0	0	2	100.00	0
1-2g	1	0	0	1	0	0	1	100.00	0
CD (5%)				0.23	0.11		0.20		0.10

Table 3: Effect of corm weight on leaf development- Averaged over years

Corm Weight	Average Cataphyll Length for Leaf Emergence						Average Number of leaves/Sprout			Total	Average Cataphyll width (cm)
	Apical		Sub apical		Auxiliary		Apical	Sub apical	Auxiliary		
	Moisture Stress	Adequate Moisture	Moisture Stress	Adequate Moisture	Moisture Stress	Adequate Moisture					
>15g	4.5	15.6	3.96	13.5	2.7	7.5	10.6	7.3	4	21.9	1.1
8-14g	3.23	12.0	2.56/	10.5	2.3	6.5	11	5.3	2	18.3	1.0
5-7g	3.4	8.0	0.53	5.0	2.3	3.5	8.3	3.3	1.6	14.2	0.7
3-5 g	3.0	4.5	1.0	3.0	2.4	2.5	3.0	2.0	0	5.0	0.5
1-2 g	2.9	3.5	0	0	0	0	2.0	0	0	2.0	0.3
CD (5%)	0.22	0.16						0.18			

Table 4: Effect of corm weight on root development - Averaged over years

Corm Weight	Adventitious roots		Fibrous		Corm		Lateral (Auxillary/Sub-apical)		Terminal		Total	
	Moisture Stress	Adequate Moisture	Moisture Stress	Adequate Moisture	Moisture Stress	Adequate Moisture	Moisture Stress	Adequate Moisture	Moisture Stress	Adequate Moisture	Moisture Stress	Adequate Moisture
>15g	61	113	5.2	8.3	0	1	2.8	4.9	1	1	9	15.3
8-14g	38	69	3.0	5	0	0.33	1.9	3.3	1	1	5.9	9.63
5-7 g	27	47	3.9	6.3	0	0	0	1	0	1	3.9	7.3
3-5g	11	34	2.0	5	0	0	0	1	0	1	2	7.0
1-2 g	9	28	2.0	5	0	0	0	1	0	1	2	7.0
CD (5%)											0.14	2.26

from 1 (1-2g) to 5 (5-7g) irrespective of position of bud,wheras, corms weighing >15 g exhibited 23.80% flowering sprouts followed by 8-14g showing 17.44 % flowering sprouts.The study thus confirms importance of corm weight on flower production. Mashayekhi et al. [11] and Mastro and Rota [12] also reported increase in flower yield with increase in corm weight as evident in table 2.

Plant development viz a viz number of leaves/sprout, average cataphyll length for leaf emergence, number of adventitious and contractile roots (Table 3,4) was also observed to be influenced by corm weight as well as availability of moisture. Study was carried under moisture stress conditions and well as under adequate moisture conditions. Average number of leaves/corm ranged from 2 (1-2g) to 21.9 (>15g).Apical buds contributed more towards leaf number (57.87%) followed by Sub-apical (29.47%) and auxiliary buds (12.68%) irrespective of corm weight and moisture , respectively although for average cataphyll length for leaf emergence both corm weight and moisture exhibited significant impact suggesting importance of both for plant development. Highest cataphyll length (15.6 cm) was observed from corms weighing >15g under adequate moisture conditions. Moisture availability had more significant effect on apical and sub apical buds in enhancing the cataphyll length by more than 5 cm, whereas, for auxiliary sprouts impact of moisture was only to the tune of around 3 cm. On an average cataphyll length of 2.7 cm was observed under moisture stress conditions as compared to 6.83 cm under adequate moisture conditions. Influence of moisture was more pronounced in bigger corms >8 g as compared to corms weighing <7 g. [13]. Similar positive effects of corm weight and moisture was observed on root development . Highest number of adventitious roots (100-117),coupled with maximum fibrous contractile (8.3),corm contractile (1), Lateral contractile(4.9) and terminal contractile (1) were observed in heavier corms (>15 g) under adequate moisture followed by corms >8 g. Better contractile root development ensures better daughter corm production.Poor root development evident from smaller corms under moisture stress conditions effects the plant development in terms of lesser number of flowering sprouts, number of leaves/ sprout and cataphyll width and length for leaf and flower emergence.

CONCLUSION

Study confirms importance of moisture and corm weight on plant development. Availability of moisture (980m^3/ha) to the heavier corms (>8 g) over a period of 90 days from 15th August confirms maximum flower production associated with better ability for daughter corm production. Corms with minimum number of productive sprouts are ideal for saffron flowering, whereas, corms with more non productive sprouts are ideal for daughter corm development.

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