Electronic Journal of Plant Breeding, 1(2): 212-216 (March 2010)

Research Notes

Influence of plant morphology on root yield in Safed Musli (C*hlorophytum borivilianum*) to identify morphological marker traits

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Abstract

The study was performed in order to assess the influence of plant morphology on root yield and its attributing traits in Safed Musli. Twenty seven germplasm lines of C*hlorophytum borivilianum* were characterized for 4 morphological features (plant architecture, flowering nature, leaf margin and canopy shape), 7 yield attributing traits (canopy spread, leaf width, leaf length, number of leaves/ plant, number of roots/ plant, root length and root diameter) and root yield/ plant. Based on morphology the genotypes were grouped into different morphotype pairs and compared using 't' test. Genotypes with flowering ability showed significantly higher mean values for canopy spread and leaf length that are significantly correlated with root yield. So flowering nature can be utilized as morphological marker for large-scale screening of germplasm lines for yield in Safed Musli.

Keywords:

Safed Musli**,** C*hlorophytum borivilianum*, morphological marker, indirect selection.

Germplasm characterization in any crop involves both continuous variables (yield components, yield, chemical traits, etc.) and discrete variables (plant architecture, leaf morphology, flower morphology, root morphology, etc.). Yield, being a complex trait with high environmental influence is considered to be the resultant variable of its component traits and so direct selection for yield *per se* may not be effective for all the time. Therefore, alternatively for yield improvement, indirect selection through component traits is considered reliable, if these traits have strong association with yield. Generally such association are determined through correlation studies, path coefficient analysis, principal component analysis, etc. Since all these yield association measures are based on metric traits, morphological features that are non-measurable could not be studied for their influence on yield. Hence the, association of yield with plant morphology needs to be determined to identify the morphological markers that not only facilitate large-scale screening of germplasm lines, but also helpful in identifying the particular genotype.

In this direction, in the present study, observations were made on Safed Musli (C*hlorophytum borivilianum*). Safed Musli an important medicinal plant, whose roots are used as aphrodisiac drug to cure general debility (Bordia *et al.* 1995). It exhibits diversified variability for several morphological features such as plant architecture, leaf morphology, leaf size, canopy shape and size, flowering nature, root morphology, etc. The variability prevalent among the germplasm lines of C*hlorophytum borivilianum* has been well described by several authors (Jat, 1993; Bordia *et al.*, 1995; Jat and Sharma, 1996; Kothari and Singh, 2001; Geetha and Maiti, 2002; Bhagat and Jadeja, 2003, Maiti and

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Geetha, 2006). The result obtained in our study is discussed here under.

The experimental material comprise of 27 germplasm lines collected from natural habitats of different eco-geographical locations of India and maintained at Research Farm of Central Institute of Medicinal and Aromatic Plants (CIMAP) – Resource Centre, Hyderabad, Andhra Pradesh, India. All germplasm lines were scored for four morphological features *i.e.* plant architecture, flowering nature, leaf margin and canopy shape and data were recorded on root yield (g/ plant) and its 7 attributing traits viz., upper-ground attributes [canopy spread (cm), leaf width (mm), leaf length (cm) and number of leaves/ plant] and under-ground attributes [number of roots/ plant, root length (cm) and root diameter (mm)] during *Kharif*, 2006.

Further, the genotypes were grouped into morphotype pairs based upon the plant morphology. The morphological features had two categories each *i.e.* plant architecture - erect/ prostrate; flowering nature - flowering/ non-flowering; leaf margin-wavy/ non-wavy and canopy shape - circular/ non-circular. Thus 4 morphotype pairs (one pair for each category) were generated.

The mean values for yield and yield attributes between the two groups of genotypes in each morphotype pair was tested for their significant difference based on unpaired 't' test utilizing statistical software Kyplot. The correlation coefficient between yield and its attributing traits was estimated as per Singh and Chaudhary (1979).

The morphotype mean values, number of genotypes in each group and 't' values of the morphotype pairs is presented in table 1. The genotypes with prostrate plant architecture exhibited higher mean value for root yield (20.23 g/plant) than erect type (19.17 g/plant). Genotypes with flowering nature (21.73 g/plant), non-wavy leaf margin (22.95 g/plant), and non-circular canopy (29.73 g/plant) yielded relatively higher quantity of roots than genotypes with non-flowering nature (17.77 g/plant), wavy leaf margin (17.17 g/plant), and circular canopy (18.25 g/plant), respectively. However, the 't' values were non-significant except for canopy spread (2.59) and leaf length (2.65) in flowering/ non-flowering morphotype pair. This shows that flowering types had significantly higher mean values for canopy spread (62.54 cm) and leaf length (30.41 cm) indicating that they possess larger leaf size and canopy spread than non-flowering types.

The significantly larger canopy area and lengthy leaves in flowering morphotypes indicated the existence of linkage between flowering nature and canopy size. This association may be attributed to the biology of floral development. The species belonging to family Liliaceae is a herbaceous plant with condensed stem disc bearing a whorl of leaves. During flowering the flowering shoots are put forth from condensed stem disc thereby exerting physical pressure pushing out the leaves apart thus increasing their length. The increase in leaf length and thus canopy spread provide large photosynthetic area, enhancing the photosynthetic efficiency of flowering types resulting in increased root yield. This is further evident from positive and significant correlation of canopy spread (0.524) and leaf length (0.636) not only with root yield and also with other traits. This linkage between flowering nature and canopy area resulting in higher root yield indicates that flowering ability of the genotypes may be used as morphological marker for selecting high yielding genotypes in Safed Musli while screening the large number of germplasm.

Among the four upper-ground traits only two *i.e.* canopy spread and leaf length showed significant positive correlation with root yield (Table 2). On the other hand all the under-ground traits (root component traits) showed significant and positive correlation with root yield. This indicated that the root component traits have better role in indirect selection for high yielding genotypes. However, the under-ground traits are not visibly available during growth phase for identification making selections and one has to wait till harvesting of roots. This leads to difficulties in identifying marker traits particularly when large number of germplasm lines are to be screened. In such situations, primary screening of the genotypes can be made utilizing easily scoreable upper-ground traits and morphological markers that has a strong association with under-ground attributes. Further, the preliminary selected genotypes can be subjected to secondary screening utilizing highly correlated root attributes.

The present methodology described is a simple technique that can be effectively utilized for large scale screening of genetic resources through identification of reliable traits and morphological markers for indirect selection. The methodology facilitates to assess the combined effect of both plant morphology and yield attributes on yield that can give a wholesome understanding on factors influencing yield. It can supplement any yield association studies and would be a great value for plant breeders to evaluate germplasm materials more efficiently to facilitate precise selection, thus effectively utilizing available genetic resources.

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Table 1. Mean values, number of genotypes and 't' values of different morphotype pairs in safed musli.

Details	No of Genotypes	Canopy Spread (cm)	Leaf Width (mm)	Leaf Length (cm)	No. of Leaves	No. of Roots	Root Length (cm)	Root Diameter (mm)	Root Yield (g/ plant)
PLANT ARCHITECTURE									
Erect	18	58.71	21.39	28.80	21.13	8.79	8.96	15.71	19.17
Prostrate	9	52.82	19.21	25.81	12.79	9.84	8.80	17.69	20.23
't' value		1.96	0.92	1.46	1.79	-0.47	0.73	-1.08	-0.20
FLOWERING NATURE									
Flowering	12	62.54	20.76	30.41	18.71	10.12	8.83	14.69	21.73
Non Flowering	15	52.11	20.58	25.72	18.06	8.35	8.97	17.71	17.77
't' value		2.59*	0.08	2.65*	0.14	0.85	-0.17	-1.80	0.79
LEAF MARGIN									
Wavy	16	54.92	19.60	26.66	18.24	8.01	8.53	16.99	17.17
Non Wavy	11	59.40	22.21	29.46	18.52	10.78	9.46	15.47	22.95
't' value		-0.99	-1.16	-1.43	-0.06	-1.35	-1.07	0.85	-1.16
CANOPY SHAPE									
Circular	24	55.95	20.38	27.58	18.18	8.83	8.69	16.41	18.25
Non Circular	3	63.13	22.91	29.56	19.70	11.58	10.63	16.08	29.73
't' value		-1.02	-0.71	-0.62	-0.20	-0.84	-0.17	0.11	-1.49

* Significance at 5% level.

Table 2. Correlation Coefficient among yield and yield components in safed musli.

Traits	Canopy Spread	Leaf Width	Leaf Length	Number of Leaves	Number of Roots	Root Length	Bottom Root Diameter	Middle Root Diameter	Top Root Diameter	Root Yield
Canopy Spread	1.000									
Leaf Width	0.499***	1.000								
Leaf Length	0.802***	0.340*	1.000							
Number of Leaves	0.117**	-0.084	0.438*	1.000						
Number of Roots	0.378*	0.028	0.586***	0.366	1.000					
Root Length	0.193	0.012	0.206	0.201	0.596**	1.000				
Bottom Root Diameter	0.345	0.221	0.207	0.136	0.155	0.166	1.000			
Middle Root Diameter	0.181	-0.053	0.194	0.255	0.420*	0.290	0.755***	1.000		
Top Root Diameter	0.252	0.075	0.213	0.195	0.308	0.260	0.570**	0.591**	1.000	
Root Yield	0.524*	0.107	0.6360***	0.356	0.899***	0.559**	0.426*	0.600***	0.512**	1.000

* Significance at 5% level, ** Significance at 1% level, *** Significance at 0.1% level.