



Useful impact of complete lockdown due to COVID-19 on selection of putatively improved progenies of *Cymbopogon jwarancusa*

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Abstract

During COVID-19 total lockdown situation, the previously established parental plants of *Cymbopogon jwarancusa* had favorable, unrestricted and equal chance of cross pollination among themselves. This was followed by undisturbed anemochory of spikelets, growth and development of progenies nearby the parental plants. The specific seasonal wind, blowing from north to south direction was responsible for fruitful dispersal of spikelets followed by their anchoring in soil, successful establishment amidst other weeds and vegetative luxuriance. Morphometric and chemometric analysis of twenty two characters in forty four progenies lead to the selection of seven putative candidate progenies viz. progenies - 3, 10, 13, 19, 34, 35 and 38 that performed better than the remaining selections in the population in their respective characters. The progeny-3 was relatively superior to the remaining six selections.

Keywords: anemochory, COVID-19 lockdown, *Cymbopogon jwarancusa*, spikelets, wind direction

Introduction

Cymbopogon jwarancusa (Jones) Schultz, family-Poaceae is a perennial C4 herb, having medicinal and aromatic properties. This bunchgrass grows luxuriantly as a weed in India and other adjoining countries. In the recent past, several researchers have come up with the use of this plant against ailments like vomiting, abdominal tumors, unconsciousness, blood impurities, skin problems etc. (Prasad *et al.*, 2014; Kirtikar and Basu, 1982; Mahmud *et al.*, 2002) [10, 5, 6]. Roots of this aromatic grass are useful in fever; root oil also gives relief in anti-microbial and skin diseases (Mohammed *et al.*, 2004) [7]. Particularly, the leaves of this plant are aromatic in nature and are widely used in soaps and perfumes. Piperitone is the common major compound found in the essential oil of leaves of this plant which is responsible for its characteristic aroma. Apart from the medicinal and aromatic uses, this grass is a good soil binder (anti-soil erosive) and plays a role in land reclamation.

Cymbopogon jwarancusa has a short life cycle as it blooms within 3 months compared to other aromatic grasses of *Cymbopogon* genera (Sarkar *et al.*, 2021; Sarkar, 2020; Sarkar 2021) [12, 11, 15]. Being a tussock forming dominant weed in monocots, it has higher viable seed production, easier dispersal mechanism of seeds (spikelets), moderately drought tolerant nature and better germination rates than other competitive weeds growing in the area. During its early growth phase or during shortage of fodder this aromatic grass is grazed by animals. *Cymbopogon jwarancusa* can adapt to different habitats which are evident by its various morphological and physiological features (Fatima *et al.*, 2018; Perlikowski *et al.*, 2019; Monteverdi *et al.*, 2008; Ahmad *et al.*, 2016; Wasim and Naz, 2020; Khan *et al.*, 2017; Al-Tawaha *et al.*, 2017; Vanhees *et al.*, 2020) [3, 9, 8, 1, 14, 4, 2, 13] most impressive among those are the adaptations for conserving water in its body.

The year 2019 will be forever remembered for the outbreak of the global pandemic called COVID-19. The consequences of this pandemic elevated further in the year 2020 and did not spare even a single functional sector in the human society. Mankind witnessed a global lockdown that directly or indirectly affected one and all. By and large the research and development sector also had its share of disturbances as well. The present study is an incidental close observation analysis during the aftermath of COVID-19 lockdown situation on the undisturbed anemochory of spikelets and invasive nature of *Cymbopogon jwarancusa*, its establishment in soil amidst luxuriance of other weeds (Figure 1) and eventual development of vegetative and flowering stages to complete its life cycle. This study also aims at screening of better aromatic chemoprofile types compared to the already existing ones.

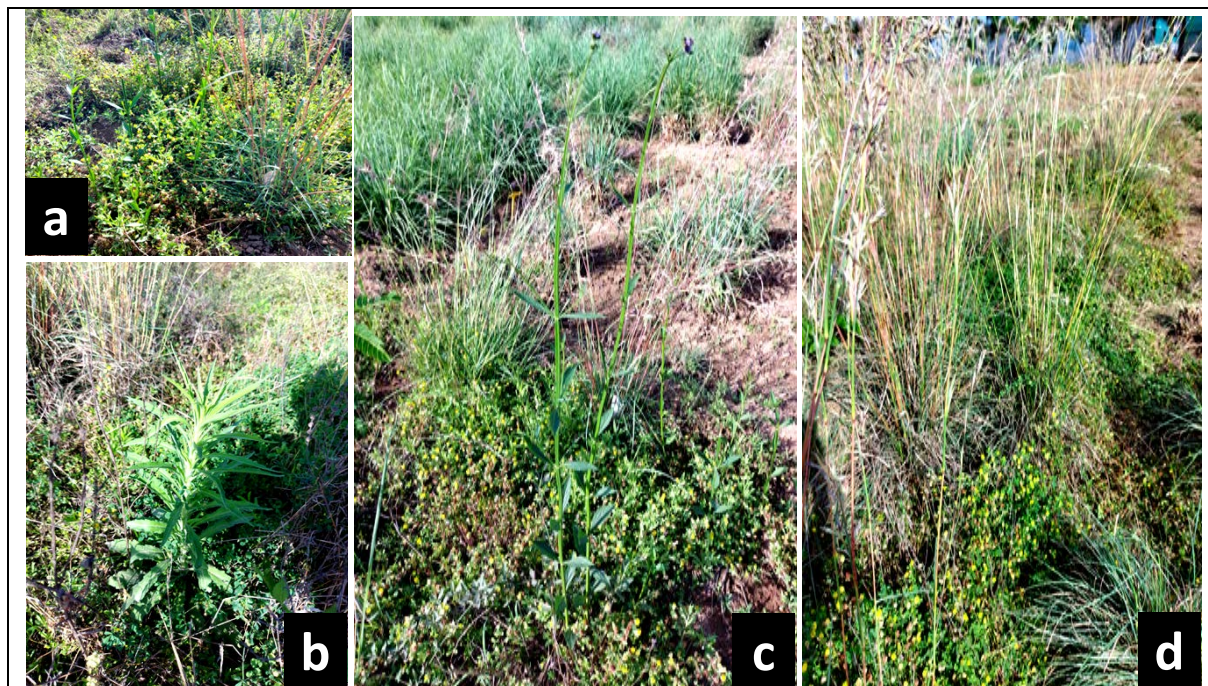


Fig 1: Complete lockdown during COVID-19 pandemic resulted in luxuriance of weeds in the earlier trial around the parent plants of *Cymbopogon jwarancusa*.

Materials and Methods

Plant material

The plants of *Cymbopogon jwarancusa* were already available in the same experimental field trial at CSIR-IIIM Field Station, Chatha, Jammu, India which is described by Sarkar *et al.*, 2021^[12]. Since, this was the only stock of plants of *C. jwarancusa* existing in the area, all other such new plants found growing nearby it were simply the progenies of the one existing in the trial. These new plants grew luxuriantly during COVID-19 lockdown. Forty four plants were selected for morphometric and chemometric analysis.

Statistical analysis

Morphometric observations (Figure 2) were recorded for statistical analysis from forty four selected plants with respect to twenty two important characters are as following: J1= Distance of spikelets dispersal (cm); J2 = Plant height (cm); J3 = Inflorescence length (cm); J4 = Number of inflorescence/clump; J5 = Leaf length (cm); J6 = Clump diameter (cm); J7 = Total inflorescence weight/clump (g); J8 = Total flowers weight/clump (g); J9 = Total inflorescence stalk weight/clump (g); J10 = Clump fresh weight (g); J11 = Clump dry weight (g); J12 = Foliar essential oil recovery (%); J13 = Inflorescence essential oil recovery (%); J14 = Flower length (cm); J15 = Flower width (cm); J16 = Node width of inflorescence stalk (cm); J17 = Weight of soil bound with roots (g); J18 = D-Limonene (%); J19 = 2-Cyclohexen-1-ol, 1-methyl-4-(1-methylethyl)-trans (%); J20 = 2-Cyclohexen-1-ol, 1-methyl-4-(1-methylethyl)-, cis- (%); J21 = 2-Carene (%); J22 = 4-Isopropyl-1-methylcyclohex-2-enol (%). The data were offered to statistical analysis using statistical software SPSS v26 for t-test and correlation analysis.

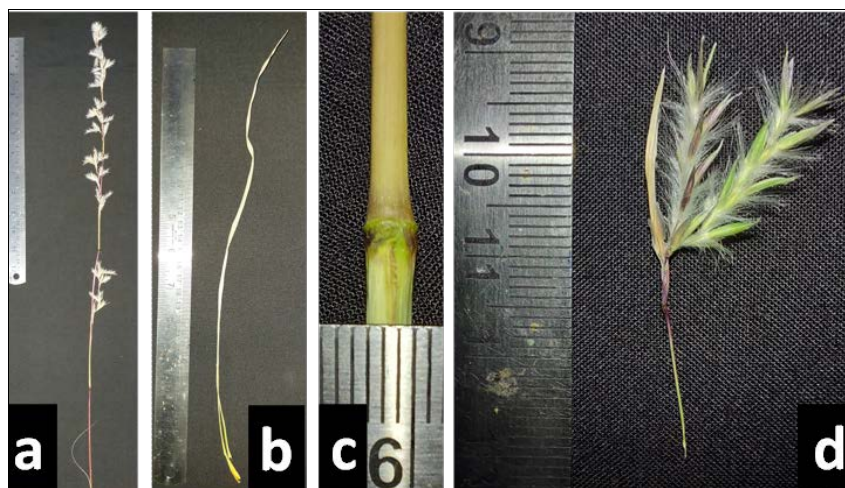
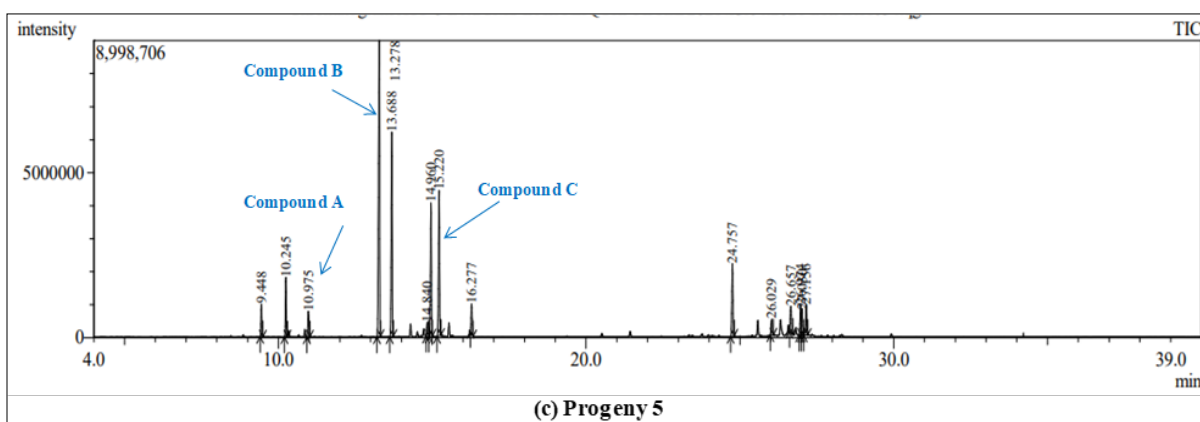
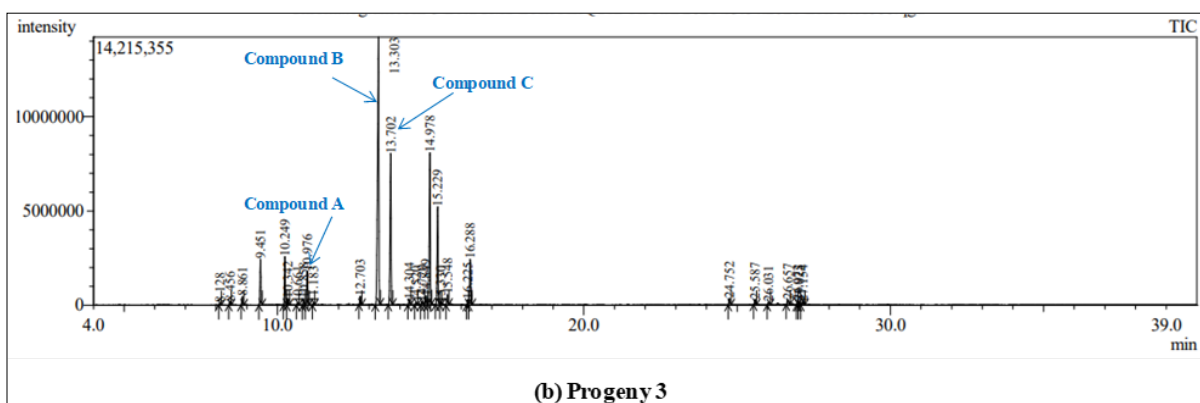
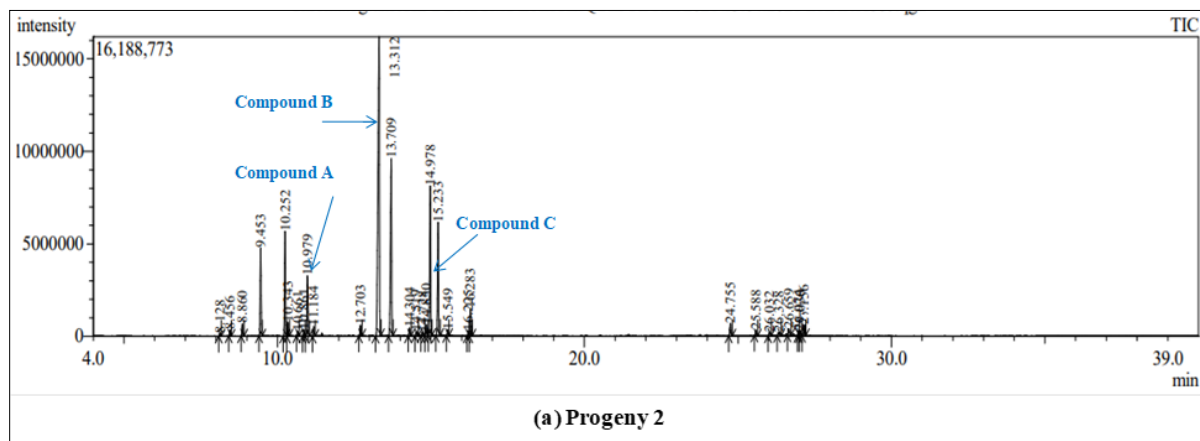


Fig 2: Some characters associated with morphometric analysis: a- Inflorescence length (cm), b- Leaf length (cm), c- Node width of inflorescence stalk (cm), d- Flower length and width (cm).

Essential oil extraction and GCMS analysis

To extract essential oil, 100 g fresh leaves were used for hydro-distillation for two hours in Clevenger type apparatus from each treatment. After cooling, the oil was separated from water and further dried using anhydrous Na_2SO_4 . Percentage of essential oil was recorded on fresh weight basis. The extracted essential oil was stored in a sealed glass vial under refrigeration at 4°C . The essential oil of each treatment was subjected to GC-MS analysis which was carried out on Agilent (S-80) series GC-MS equipped with a Combi Pal auto-sampler. The columns used were Agilent J & W DB-5 GC capillary column ($30\text{ m} \times 0.25\text{ mm i.d.}, 0.25\text{ }\mu\text{m}$) DB-5. Helium was used as the carrier gas with flow rate of 1 ml/min . $2\text{ }\mu\text{l}$ injection of sample was used for analysis. The column temperature was initially programmed at 60°C held for 5 min and increased to 280°C at 10°C/min for 27 min through splitless mode. Injector and detector temperatures were 250°C . The ionization energy was 70 eV and a mass range of $45\text{--}500\text{ AMU}$. The management of the GC-MS system, parameter settings for GC and mass spectrometry, data receipt and processing were performed using Agilent Chemstation. The spectrums of the components were compared with the database of spectrum of known components stored in the NIST library (Figure 3a-e).



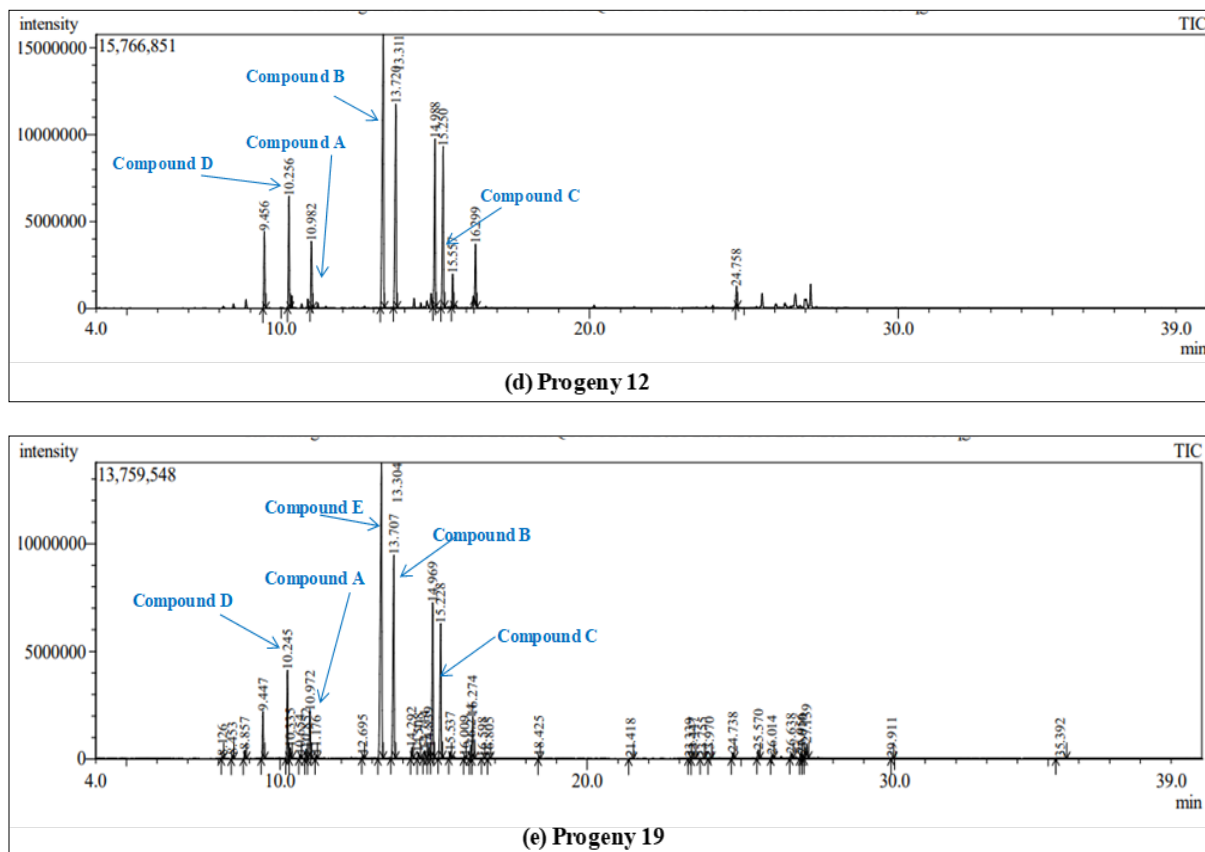


Fig 3a-e: GCMS chromatograms of essential oil of some progenies of *Cymbopogon jwarancusa* where, Compound A= D-Limonene; Compound B= 2-Cyclohexen-1-ol, 1-methyl-4-(1-methylethyl)-trans (%); Compound C= 2-Cyclohexen-1-ol, 1-methyl-4-(1-methylethyl)-, cis- (%); Compound D= 2-Carene (%); Compound E= 4-Isopropyl-1-methylcyclohex-2-enol.

Results and discussion

The imposition of complete lockdown due to COVID-19 situation has led to a minimum or no anthropogenic and cultural activity in and around the experimental trial site that has provided an undisturbed and conducive environment for unrestricted anemochory from the *C. jwarancusa* parent plants for nearly a year. Among the forty four progenies, two progenies established in the east, seven progenies established in the west, only one progeny established in the north, twenty progenies established in the south, six Progenies established in the south-west and five progenies established in the south-east direction of the already established parent plants of *C. jwarancusa* (Figure 4).

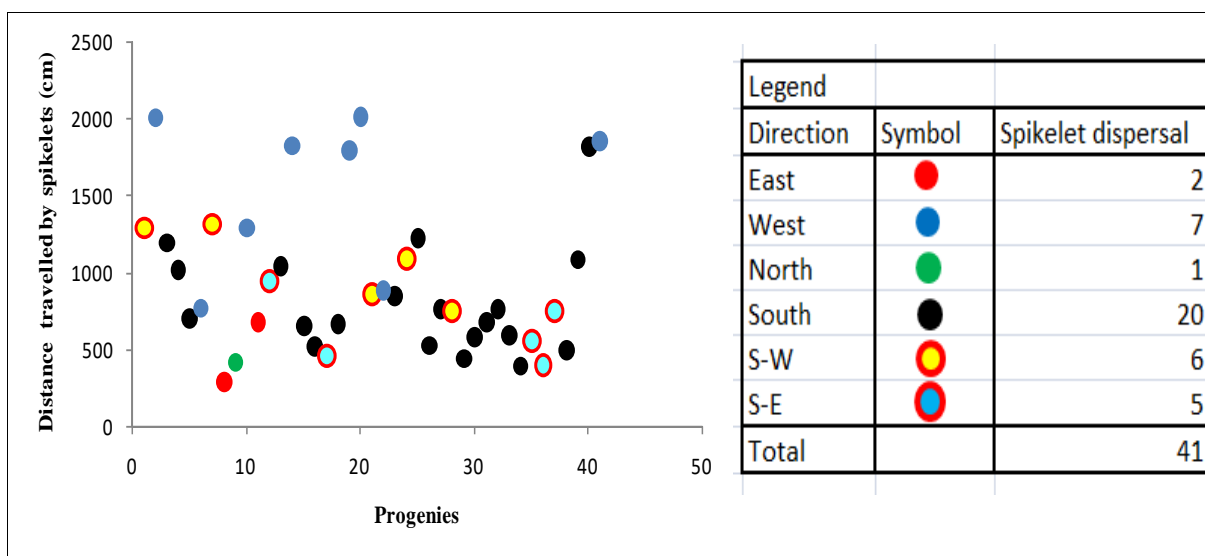


Fig 4: Establishment of *Cymbopogon jwarancusa* progenies on account of spikelet dispersal from the parental plants.

Unrestricted wind from all directions has helped in free dispersal of seeds (spikelets) during COVID-19 lockdown, which resulted in the establishment and growth of new progenies of *C. jwarancusa* around the already existing mature plants present in the older experimental trial (Figure 5). As there was only one establishment of progeny in the north direction, it is evident that the seasonal wind coming from north towards all other directions was the most effective in dispersal of spikelets of *C. jwarancusa*. Moreover, the season of the year in which wind direction specifically stays from north to south proved to be the best time for germination of spikelets and their establishment as maximum viable progenies moved along north-south wind direction from the parent plants.

It is impossible to derive complete understanding about the genetic background of each of these progenies as every parent had even opportunities to cross with other parent all around the year. However, it is clear that the progenies essentially have a very narrow genetic base, as a result of which a low genetic variability is almost certain.

A total of forty four such progenies were sampled from the growing population which was studied with respect to twenty two morphometric and chemometric characters.

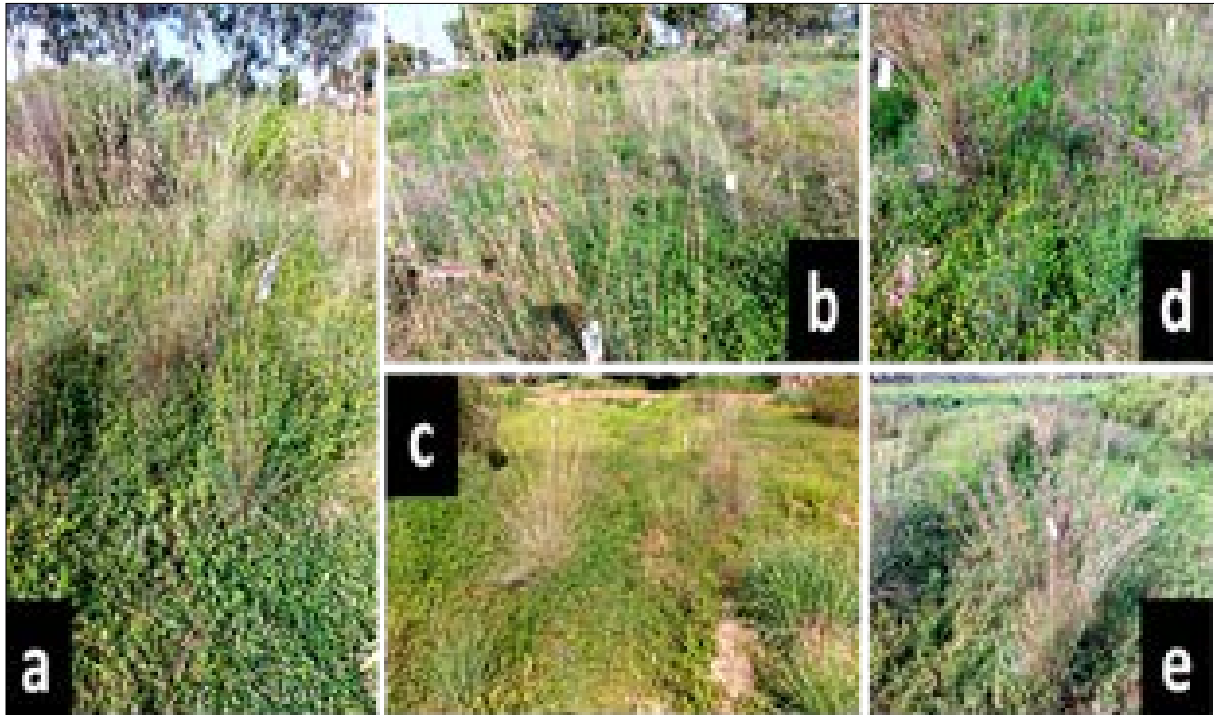


Fig 5a-e: Unrestricted dispersal of *Cymbopogon jwarancusa* spikelets, their germination and growth into progeny plants amidst weeds.

One sample t-test confirmed the presence of significant differences between all the characters (Table 1) in the progenies. The correlation analysis (Table 2) represented that the *highest* significant correlation of 0.997** existed between total inflorescence stalk weight(g) and total inflorescence weight/clump(g) followed by 0.905** between total flower weight/clump(g) and total inflorescence weight/clump(g); *higher* significant correlation of 0.899** existed between clump dry weight(g) and clump fresh weight(g), 0.868** between total inflorescence stalk weight(g) and total flower weight/clump(g), 0.807** between clump diameter(cm) and number of inflorescence/clump; *high* significant correlation of 0.758** existed between clump fresh weight(g) and total inflorescence weight/clump(g), 0.750** between clump fresh weight(g) and total inflorescence stalk weight(g), 0.726** between flower width(cm) and flower length(cm), 0.720** between clump fresh weight(g) and total flower weight/clump(g); *medium* significant correlation of 0.575** existed between total inflorescence weight/clump(g) and clump diameter(cm), 0.524** between number of inflorescence/clump and inflorescence length(cm), 0.523** between leaf length(cm) and plant height(cm), 0.417** between oil recovery from herb(%) and total inflorescence weight/clump(g), 0.414** between oil recovery from herb(%) and total flower weight/clump(g), 0.409** between oil recovery from herb(%) and total inflorescence stalk weight/clump(g).

Table 1: t-values of twenty two characters of forty four progenies of *Cymbopogon jwarancusa*.

Sl No	Traits	t –value df = 43
1	Distance of spikelets dispersal (cm)	11.134**
2	Plant height(cm)	22.721**
3	Inflorescence length (cm)	36.404**
4	Number of inflorescence/clump	9.095**
5	Leaf length(cm)	22.492**
6	Clump diameter (cm)	14.175**
7	Total inflorescence weight/clump (g)	8.143**
8	Total flowers weight/clump (g)	7.121**
9	Total inflorescence stalk weight/clump (g)	8.163**
10	Clump fresh weight (g)	8.374**
11	Clump dry weight (g)	8.082**
12	Foliar essential oil recovery (%)	10.614**
13	Inflorescence essential oil recovery (%)	5.132**
14	Flower length (cm)	6.395**
15	Flower width (cm)	5.816**
16	Node width of inflorescence stalk (cm)	4.471**
17	Weight of soil bound with roots (g)	3.775**
18	D-Limonene (%)	4.914**
19	2-Cyclohexen-1-ol, 1-methyl-4-(1-methylethyl)-trans (%)	6.798**
20	2-Cyclohexen-1-ol, 1-methyl-4-(1-methylethyl)-, cis- (%)	6.128**
21	2-Carene (%)	3.691**
22	4-Isopropyl-1-methylcyclohex-2-enol (%)	2.071*

* = $p < 0.05$, ** = $p < 0.01$, respectively.

On the basis of individual performances of the progenies, the mean distances travelled by the spikelets was 876.159cm however, progeny-20 travelled about 2023cm; mean plant height of the progenies were about 57.05cm however, progeny-34 measured about 89cm; mean inflorescence length of the progenies were about 151.72cm however, progeny-38 measured about 208cm; mean number of inflorescence/clump of the progenies were about 53.89 however, progeny-19 had about 126; mean leaf length of the progenies were about 33.33cm however, progeny-13 measured about 70cm; mean clump diameter, total inflorescence weight/clump, total inflorescence stalk weight/clump, clump fresh weight of the progenies were about 75.05cm, 227.56g, 195.85g and 158.73g respectively, however, progeny-3 exhibited highest records viz. 140cm, 811g, 721.79g and 504g respectively; maximum essential oil recovery from herbage of 0.75% was obtained from progeny-35 with respect to mean recovery of 0.32% and maximum essential oil recovery from inflorescence of 0.38% was obtained from progeny-10 with respect to mean recovery of 0.07%; maximum D-Limonene content of 5.35% and 2-Carene content of 11.95% was observed in progeny-38 compared to mean content of 1.38% and 1.89% respectively; maximum 4-Isopropyl-1-methylcyclohex-2-enol content of 32.57% was observed in progeny-19 compared to mean content 2.85% in progenies.

The screening of putative progenies from the naturally growing population of *C. jwarancusa* largely depended on the performances of the studied characters in this study. The progenies 3, 10, 13, 19, 34, 35 and 38 performed better than the rest of the selections present in the population including check (parents) and are therefore superior selections. Further assessment in the form of a replicated trial will eventually lead to the selection of the best candidate among the seven selections in terms of morphometric and chemometric characters.

Table 2: Correlation matrix represented by twenty two characters and forty four progenies of *Cymbopogon jwarancusa*.

	J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J11	J12	J13	J14	J15	J16	J17	J18	J19	J20	J21	J22
J1	1																					
J2	-0.091	1																				
J3	0.161	0.420**	1																			
J4	-0.133	0.477**	0.524**	1																		
J5	0.162	0.523**	0.438**	0.051	1																	
J6	-0.149	0.597**	0.709**	0.807**	0.230	1																
J7	0.192	0.560**	0.536**	0.545**	0.389**	0.575**	1															
J8	0.084	0.517**	0.359*	0.419**	0.361*	0.446**	0.905**	1														
J9	0.207	0.556**	0.558**	0.558**	0.386**	0.587**	0.997**	0.868**	1													
J10	-0.089	0.675**	0.539**	0.395**	0.537**	0.631**	0.758**	0.720**	0.750**	1												
J11	-0.100	0.621**	0.527**	0.331*	0.520**	0.581**	0.614**	0.597**	0.605**	0.899**	1											
J12	0.068	0.307*	0.314*	0.333*	0.115	0.338*	0.417**	0.414**	0.409**	0.289	0.300*	1										
J13	-0.190	0.151	-0.073	0.053	-0.220	0.020	-0.100	-0.096	-0.099	-0.119	-0.059	0.151	1									
J14	-0.095	0.398**	0.255	0.213	0.402**	0.394**	0.156	0.046	0.173	0.248	0.184	0.112	0.333*	1								
J15	0.037	0.285	0.467**	0.289	0.359*	0.491**	0.217	0.073	0.239	0.276	0.254	0.029	0.029	0.726**	1							
J16	-0.366*	0.177	0.476**	0.488**	0.084	0.650**	0.092	-0.036	0.114	0.246	0.287	0.072	0.154	0.582**	0.672**	1						
J17	-0.154	0.301*	0.286	0.538**	0.302*	0.464**	0.322*	0.281	0.323*	0.372*	0.404**	0.213	-0.075	0.315*	0.309*	0.414**	1					
J18	0.256	0.058	0.382*	0.231	0.324*	0.244	0.321*	0.224	0.332*	0.208	0.207	0.244	-0.077	0.260	0.317*	0.293	0.413**	1				
J19	0.401**	0.190	0.395**	0.275	0.352*	0.323*	0.473**	0.372*	0.482**	0.284	0.195	0.287	-0.037	0.310*	0.369*	0.199	0.411**	0.582**	1			
J20	0.176	0.288	0.443**	0.157	0.281	0.252	0.379*	0.277	0.391**	0.315*	0.249	0.123	0.084	0.243	0.432**	0.154	0.171	0.363*	0.683**	1		
J21	0.188	0.096	0.312*	0.231	0.078	0.288	0.225	0.197	0.226	0.113	0.113	0.147	-0.063	0.196	0.321*	0.406**	0.292	0.640**	0.395**	0.302*	1	
J22	0.498**	0.030	0.105	0.070	-0.182	-0.043	0.184	0.091	0.197	-0.131	-0.087	0.172	0.028	-0.191	-0.082	-0.160	-0.158	0.269	-0.030	0.056	0.301*	1

Where, J1= Distance of spikelets dispersal (cm), J2=Plant height (cm), J3=Inflorescence length (cm), J4=Number of inflorescence/clump, J5=Leaf length (cm), J6=Clump diameter (cm), J7=Total inflorescence weight/clump (g), J8=Total flower weight/clump (g), J9=Total inflorescence stalk weight (g), J10=Clump fresh weight (g), J11=Clump dry weight (g), J12= Foliar essential oil recovery (%), J13= Inflorescence essential oil recovery (%), J14=Flower length (cm), J15=Flower width (cm), J16= Node width of inflorescence stalk (cm), J17=Soil bound with roots (g), J18=D-Limonene (%), J19=2-Cyclohexen-1-ol, 1-methyl-4-(1-methylethyl)-trans (%), J20=2-Cyclohexen-1-ol, 1-methyl-4-(1-methylethyl)-, cis- (%), J21=2-Carene (%), J22=4-Isopropyl-1-methylcyclohex-2-enol (%)

* = $p < 0.05$, ** = $p < 0.01$, respectively.

Conclusion

The progenies 3, 10, 13, 19, 34, 35 and 38 performed better than the rest with respect to the specific characters like plant height, inflorescence length, number of inflorescence/clump, leaf length, clump diameter, total inflorescence weight/clump, total inflorescence stalk weight/clump, clump fresh weight, essential oil recovery from herbage and inflorescence and some secondary metabolite contents. Among the above seven selections, progeny-3 has better overall performance than the other six selections.

Ethical approval

This article does not contain any studies with human participants or animals performed by author.

Declaration of competing interest

The author declares that there is no conflict of interest.

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References

1. Ahmad KS, Hameed M, Deng J, Ashraf M, Hamid A, Ahmad F *et al.* Ecotypic adaptations in Bermuda grass (*Cynodon dactylon*) for altitudinal stress tolerance. *Biologia*,2016;71(8):885-895.
2. Al-Tawaha AR, Turk MA, Abu-Zaitoon YM, Aladaileh SH, Al-Rawashdeh IM, Alnaimat S *et al.* Plants adaptation to drought environment. *Bulgarian Journal of Agricultural Science*,2017;23(3):381-388.
3. Fatima S, Hameed M, Ahmad F, Ashraf M, Ahmad R. Structural and functional modifications in a typical arid zone species *Aristida adscensionis* L. along altitudinal gradient. *Flora*,2018;249:172-182
4. Khan N, Bano A, Babar MA. The root growth of wheat plants, the water conservation and fertility status of sandy soils influenced by plant growth promoting rhizobacteria. *Symbiosis*,2017;72(3):195-205.
5. Kirtikar KR, Basu BD. *Indian Medicinal Plants*. 2nd edi, vol I & II International book distributor, Dehradun, India, 1982.
6. Mahmud K, Naseer R, Shahid M, Rashid S. Biochemical studies and trace elements profiles of *Cymbopogon jwarancusa*. *Asian J plant sci*,2002;1(1):57-58.
7. Mohammed S, Kasera PK, Shukla JK. Unexploited plants of potential medicinal value from the Indian Thar desert. *Natural Product Radiance*,2004;3(2):30-34.
8. Monteverdi CM, Lauteri M, Valentini R. Biodiversity of plant species and adaptation to drought and salt conditions. Selection of species for sustainable reforestation activity to combat desertification. In *Biosaline agriculture and high salinity tolerance* (pp. 197-206). Birkhäuser Basel, 2008.
9. Perlikowski D, Augustyniak A, Masajada K, Skirycz A, Soja AM, Michaelis A *et al.* Structural and metabolic alterations in root systems under limited water conditions in forage grasses of *Lolium-Festuca* complex. *Plant Science*,2019;283:211-223.
10. Prasad C, Singh D, Shukla O, Singh UB. *Cymbopogon jwarancusa*-An important medicinal plant: A review. *The Pharma Innovation*, 3(6, Part A), 2014, 13.
11. Sarkar S. *Aromatic Grasses – Experience with some Cymbopogon sp* (ISBN9789390541799) published by AkiNik Publications, New Delhi, 2020.
12. Sarkar S, Meena R, Verma I, Pal J, Kumar K, Thapa PS *et al* Genetic variability, character association and path analysis of oil yield and its component characters in *Cymbopogon* sp. *Acta Ecologica Sinica*,2021;41(6):584-590.
13. Vanhees DJ, Loades KW, Bengough AG, Mooney S, Lynch JP. Root anatomical traits contribute to deeper rooting of maize under compacted field conditions. *Journal of Experimental Botany*,2020;71(14):4243-4257.
14. Wasim MA, Naz N. Anatomical adaptations of tolerance to salt stress in *Cenchrus ciliaris* L., a saline desert grass. *Journal of Animal and Plant Sciences*,2020;30(6):1548-1566.
15. Sarkar S. *Studies in Medicinal and Aromatic Crops* (ISBN9781913482367) published by Rubicon Publications, London, 2021.