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IDENTIFICATION OF POTENTIAL GENOTYPES OF CORIANDER (*Coriandrum sativum* L.) SUITABLE FOR RAINFED VERTISOLS

K. Giridhar*, S. Surya Kumari, A. Rajani[1], C. Sarada[1] and L. Naram Naidu[2]

AICRP on Spices,[1]AICRP on Vegetable Crops, [2] Chillies Improvement Project, Horticultural Research Station, Dr. Y.S.R. Horticultural University, Lam, Guntur - 522 034, Andhra Pradesh (India)
*e-mail: *gkalidasu@yahoo.com*

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ABSTRACT

The present study was conducted during 3 consecutive years (2009-2010 to 2011-12) at Horticultural Research Station, Lam, Andhra Pradesh (India) to evaluate ten promising and diverse genotypes of coriander (*Coriandrum sativum* L.) procured from different states of India. Maximum yield was achieved in genotype LCC-237 (959.0 kg ha^{-1}) followed by LCC-236 (897 kg ha^{-1}) which were on par with each other but significantly superior over check variety Sudha (723 kg ha^{-1}). Considering the stability parameters for yield, genotypes RKD-13 and LCC-236 with almost unit regression (-0.90 and 1.12, respectively) may be considered as stable genotypes. The genotype LCC-236 with significant deviation in regression coefficient may be considered as plastic genotype that outperformed other genotypes including best check (Sudha) in all the seasons tested. The mean performance of genotype RKD-13 was significantly lower than check Sudha, hence considered as a poor yielder. Early flowering and maturity, coupled with superiority in these traits, when correlated with yield was found to be the reason for better performance of genotype LCC-236 under diverse environmental conditions. This genotype also possessed high essential oil content than other genotypes evaluated.

Key words: Coriander, rainfed vertisols, soil moisture, stability, yield

INTRODUCTION

Coriander (*Coriandrum sativum* L.) is a native of Mediterranean region wherefrom it spread to Europe, Asia, North- and South-America and Australia. It is the most important seed spice crop cultivated throughout the world both for seed and green purpose. It is grown in more than fifty countries with India at ranking 1st, both in area and production followed by Mexico, China, former Soviet Union, Central America and South America (Morales-Payan, 2011). The crop grows in tropics and requires a cool but comparatively dry frost-free climate, particularly at flowering and seed formation stages (Sharma and Sharma, 2004). It is grown in almost all the states of India either for grain or leaf or dual purpose. In India the crop is cultivated mainly in Rajasthan, Madhya Pradesh, Andhra Pradesh, Orissa, Tamil Nadu and Karnataka on an area of 5.43 lakh ha with a production of 5.24 lakh metric tonnes (Tiwari, 2014). The average crop productivity is only 965 kg ha^{-1} and is much lower in rainfed farming situation (477 kg ha^{-1}). The low productivity under rainfed situation is mainly due to terminal moisture stress that affects growth and productivity. Growing coriander in rainfed vertisol farming situation demands highly productive types with short (75 days) to medium (85-100 days) duration for cultivation. Locally grown indigenous varieties are low in productivity and give poor returns to the farmers. Critical evaluation of available selections of improved types with high yield potential/ traits is of great value to the breeder for crop improvement (Moniruzzaman, 2013b). Mengesha and Getinetalemaw (2010) evaluated some Ethiopian coriander genotypes and reported that identification and evaluation of elite or promising genotypes for yield and quality is an important crop improvement strategy. Sarada and Giridhar (2009, 2011) opined that it is possible to realize 1500 kg ha^{-1} under rainfed conditions if a proper combination of varieties and management are available to the farmers. Keeping this in view, the present study was undertaken to evaluate promising diverse genotypes from across India.

MATERIALS AND METHODS

The present experiment was conducted in consecutive three years from 2009-2010 to 2011-2012 under rainfed conditions at AICRP on Spices, Horticultural Research Station, Lam, Andhra Pradesh (India) which is located at an altitude of 36.9 m amsl with geographical coordinates of 6°18′04.11"N and 80°26', 36.37"E. The farming situation was rainfed - vertisols (black cotton soils). The experimental soil was medium in available N and P_2O_5 but high in exchangeable K_2O. Ten promising genotypes from 5 AICRP centers on spices were procured to test their performance, yield and quality. These genotypes were evaluated alongwith 3 checks in a randomized block design with three replications. The genotypes were RKD-13, RKD-18 (from Udaipur, Rajasthan), UD-475, UD-801 (from Jobner, Rajasthan), LCC-236, LCC-237 (from Guntur, Andhra Pradesh), DH-220, DH-233 (from Hisar, Haryana) and NDCor-30, NDCor-49 (from Kumargunj, Uttar Pradesh). These genotypes were evaluated along with Hisar Anand, Local (Kunchanapally local) and Sudha as checks. The crop was raised at a plant spacing of 10 cm x 10 cm. The seed were sown @ 15 kg ha^{-1}. The crop was sown during 2nd fortnight of November and harvested during 2nd fortnight of February in all the years. A basal fertilizer dose of 45 kg N, 40 kg P_2O_5 and 20 kg K_2O ha^{-1} was given at the time of soil preparation each year. Soil was prepared to a fine tilth and the seed sown in rows using a cattle pair. At 20 days after sowing (DAS), the plants were thinned 10 cm apart to maintain a uniform plant population. Need-based plant protection measures were taken up to raise a healthy crop. Plants were uprooted at harvest. Threshing was done with wooden sticks and seeds winnowed to remove any impurities. Ten randomly selected plants from each replication were used for recording of yield attributes. Plant height was measured with the help of a scale. The number of primary branches, number of secondary branches, number of umbels plant^{-1}, umbels plant^{-1} and fruits umbel^{-1} were assessed by counting from the plant samples. Days to 50% flowering and maturity were assessed visually. Total grain yield was obtained from net plot yield which was converted to per hectare yield. Essential oil content was assessed using hydro-distillation using Clevenger apparatus (British Pharmacopoeia, 1999). Essential oil yield was calculated from essential oil content and grain yield. The data was analyzed using appropriate statistical method to draw valid inferences (Gomez and Gomez, 1984). Stability parameters for grain yield and essential oil content and yield were analyzed and assessed using the model of Eberhart and Russell (1966).

RESULTS AND DISCUSSION

The pooled analysis of 3 years data indicated that the genotypes under evaluation varied significantly with respect to yield and yield attributes studied. The genotypes differed significantly in flowering and maturity (Table 1). The genotype LCC-236 was the earliest taking minimum number of days to 50% flowering (51.3 days) as against check Sudha (53.7 days). The number of days taken to maturity was minimum in genotype LCC-237 (93.9 days) followed by LCC-236 (94.6

Table 1: Vegetative, flowering, maturity and fruiting characters of coriander genotypes

Genotypes	Plant height (cm)	No. of primary branches	No. of secondary branches	Umbels plant^{-1}	Umbellets umbel^{-1}	No. of fruits umbel^{-1}	Days to 50% flowering	Days to maturity
RKD-13	65.9	5.0	15.0	21.8	6.8	34.2	53.3	95.0
RKD-18	63.0	4.4	13.7	20.1	6.8	37.0	52.4	94.6
UD-475	66.0	3.8	11.9	17.5	6.1	33.4	58.4	102.6
UD-801	60.9	5.4	16.7	19.1	6.4	35.1	60.3	101.4
LCC-236	62.3	5.0	13.9	22.2	6.5	36.7	51.3	94.6
LCC-237	68.0	4.9	12.5	24.4	7.1	37.5	52.3	93.9
DH-220	56.7	4.6	12.4	18.5	5.8	27.9	63.1	101.9
DH-233	61.7	4.3	11.9	18.1	6.0	31.3	60.8	103.3
NDCor-30	59.7	4.2	13.3	18.1	6.5	31.5	61.9	101.3
NDCor-49	59.8	4.4	10.9	18.8	6.5	30.0	60.7	102.8
Hisar Anand	57.8	3.2	11.7	17.2	5.3	28.0	63.0	108.1
Local	58.5	3.3	9.8	15.4	5.1	26.8	53.3	96.7
Sudha	61.4	3.7	12.8	18.7	6.0	28.4	53.7	97.0
$CD_{0.05}$	4.4	0.5	1.4	2.3	0.5	3.0	0.6	0.9
CV (%)	7.7	11.3	12.1	13.0	8.9	10.0	1.2	1.0

days) and RKD-18 (94.6 days) which were at par with one another and significantly earlier than the check Sudha (97.0 days). Datta and Choudhuri (2006) also reported that significant variation existed in days to flowering and maturity of diverse coriander genotypes.

Among the genotypes evaluated, maximum plant height was recorded in genotype LCC-237 followed by RKD-18 which were at par with each other but significantly superior to check variety Sudha (61.4 cm). Maximum primary branches was noticed in genotype UD-801 (5.4) followed by LCC-236(5.0) which were at par but significantly superior over Sudha (3.7). Maximum secondary branches were recorded in genotype UD-801 (16.7) which was superior to all other genotypes. Maximum number of umbels was in genotype LCC-237 (24.4) followed by LCC-236 (22.2) which were at par but significantly superior over others. The number of umbellets umbel^{-1} was maximum in genotype LCC-237 (7.1) followed by RKD-13 (6.8) and RKD-18 (6.8) which were at par with one another and significantly superior over check Sudha (6.0). Highest number of fruits umbel^{-1} was seen in genotype LCC-237 (37.5) followed by LCC-236 (36.7) which were at par with each other.

Only two genotypes performed significantly better than check Sudha (Table 2). Maximum yield was recorded in genotype LCC-237 (959.0 kg ha^{-1}) followed by LCC-236 (896.8 kg ha^{-1}) which were at par and significantly superior to the check Sudha (722.8 kg ha^{-1}). The poor performance of other genotype may be attributed to their inability to cope up with mid-season and terminal moisture stress prevailing in the rainfed farming situation.

Higher grain yield in coriander is always associated with the number of primary and secondary branches and umbels plant^{-1} and fruits umbel^{-1}. Moniruzzaman *et al*. (2013a) reported that yield traits in coriander differed significantly so offer a good scope for the selection of better genotypes. The genotypes LCC-236 and LCC-237 proved superior in

Table 2: Grain yield, essential oil content and oil yield of coriander genotypes evaluated

Genotypes	Grain yield (kg ha^{-1})	Oil (%)	Oil yield (L ha^{-1})
RKD-13	616.0	0.49	2.97
RKD-18	727.4	0.51	3.70
UD-475	568.8	0.44	2.59
UD-801	530.9	0.44	2.47
LCC-236	896.8	0.52	4.69
LCC-237	959.0	0.54	5.17
DH-220	646.1	0.41	2.64
DH-233	506.9	0.45	2.30
NDCor-30	561.1	0.4	2.28
NDCor-49	590.7	0.47	2.81
Hisar Anand (c)	531.2	0.32	1.75
Local (c)	456.2	0.32	1.48
Sudha (c)	722.8	0.46	3.31
$CD_{0.05}$	62.7	0.05	0.38
CV (%)	10.5	11.40	13.90

Table 3: Pooled ANOVA for stability parameters for grain yield, essential oil and oil yield

Source	D.F.	MSS		
			Essential oil	
		Yield	Content	Yield
Genotypes	12	67954.98**	0.0141**	3.389**
Environment (genotype x environment)	26	36351.20**	0.0102**	1.250**
Environment (linear)	1	310801.94**	0.2198**	18.120**
Genotype x environment (linear)	12	49437.47**	0.0019**	0.7258**
Pooled deviation	13	3159.99	0.0018	0.4359
Pooled error	72	415.56	0.0023	0.1552

**Significant at 1%; DF = degrees of freedom

these traits than other genotypes. These two genotypes flowered early and reached 50% flowering in a short time thus adopted and performed better in a residual moisture conditions. The genotypes RKD-13 and RKD-18 in-spite of the desirable attribute i.e. early flowering were significantly poor in yield and yield attributes over genotypes LCC-237 and LCC-236. The advantage to a genotype derived from early flowering is to be coupled with the conversion of source to sink during subsequent period, which solely depends on the genotype architecture and inherent genetic potential. Presumably not only behaviour and duration of flowering but also superiority in important yield traits are crucial for the success of a genotype in rainfed vertisols. Malik and Tehlan (2013) reported that superiority of a genotype depends mainly on the number of umbels plant^{-1}. Meena *et al*. (2013) while evaluating certain promising coriander genotypes under irrigated-black soil farming situation opined that yield of diverse coriander genotypes varied with soil moisture and nutritional status. Kamineni *et al*. (2008) while evaluating drought tolerance of coriander germplasm opined that crop duration on phenology is crucial for better performance of a variety in rainfed situation. Singh *et al*. (2011) reported that the characters, umbels plant^{-1}, branches plant^{-1} and early flowering were the most important traits which directly or indirectly influenced seed yield of promising genotypes in aridisols of Rajasthan under irrigated conditions. It is suggested that for improving seed yield in coriander more emphasis be laid on plant height, primary branches plant^{-1}, total branches plant^{-1} and fruit yield. Our results are in concordance with those of Singh and Singh (2013).

Among genotypes, maximum oil content was observed in LCC-237 (0.54% v/w) followed by LCC-236 (0.52% v/w) which were at par but significantly superior over check Sudha (0.46% v/w). Oil yield was significantly high in genotype LCC-237 (5.17 L ha^{-1}) followed by LCC-236 (4.69 L ha^{-1}) as compared to Sudha (3.31 L ha^{-1}) and Hisar Anand (1.75 L ha^{-1}). Kalra *et al*. (1999) opined that genotypes differ in their oil content based on the genotype, yield and test weights.

Pooled analysis of variance for 12 genotypes revealed that genotypes, environments and genotype x environment interaction were significant for yield and essential oil content and yield (Table 2) which may be attributed to significant mean squares contributed by environment (linear), genotype x environment (linear) and pooled deviation. The linear regression (βi) is considered as a measure of response to particular genotype to the environment whereas deviation from regression (s^2d) as small as possible, preferably zero (Becker, 1988). Estimates of stability parameters mean (x), regression coefficient (βi) and deviation from regression (s^2d) for grain yield, essential oil content and essential oil yield are presented in Table 4.

Of the entries studied, only 5 entries for yield, 7 entries for essential oil content and 4 entries for essential oil yield recorded more than the population mean of the traits. The regression coefficient values ranged from -0.9 to 4.1 for yield, 0.44 to 1.56 for essential oil content and 0.01 to 2.38 for essential oil yield. For grain yield, deviation from regression was significant and the entries that differed significantly were genotypes UD-475 (77.4), LCC-236 (12.77) and DH-233 (12.72). Considering the stability parameters for yield, genotypes RKD-13 and LCC-236 with almost unit regression (-0.90 and 1.12, respectively) may be considered as stable genotypes. The mean performance of genotype RKD-13 was significantly lower than check variety Sudha, hence was

Table 4: Pooled ANOVA for stability parameters for grain yield, essential oil and oil yield

Genotypes	Yield (kg ha^{-1})			Essential oil (% v/w)			Essential oil yield (L ha^{-1})		
	Mean (x)	βi	s^2d	Mean	βi	s^2d	Mean	βi	s^2d
RKD-13	616.0	-0.90	-1.13	0.49	0.44	1.35	2.97	-0.37*	-11.06
RKD-18	727.4	-0.08	-0.42	0.51	0.54	0.73	3.70	0.60	2.19
UD-475	568.8	1.91*	77.40**	0.44	0.88	4.86	2.59	1.36	2.58
UD-801	530.9	4.10	7.36	0.44	0.62	2.14	2.47	2.38	1.91
LCC-236	896.8	1.12	12.77*	0.52	1.14	3.71	4.69	1.31	2.84
LCC-237	959.1	2.82	4.79	0.54	1.22	3.22	5.17	2.02	3.09
DH-220	646.1	1.64	7.85	0.41	0.86	2.88	2.64	0.93	5.90
DH-233	506.9	0.63	12.72*	0.45	1.25	6.15	2.30	0.89	28.44*
NDCor-30	561.1	0.84	1.96	0.40	1.42	4.49	2.28	1.00	1.73
NDCor-49	590.7	0.67	5.72	0.47	1.56	19.62*	2.81	1.13	2.69
Hisar Anand (c)	531.2	0.74	2.40	0.32	1.03	26.63*	1.75	0.78	3.23
Local (c)	456.2	-1.35*	-9.47	0.32	1.14	3.71	1.48	0.01	0.01
Sudha (c)	722.8	0.86	5.18	0.46	0.91	9.57	3.31	0.96	4.40
Population mean	639.6	-	-	0.44	-	-	2.94	-	-

**Significant at 1%; *Significant at 5%; c = control

considered as a poor yielder. The genotype LCC-236 with significant deviation in regression coefficient was considered as plastic genotype that outperformed other genotypes including best check (Sudha) in all the seasons tested. The plasticity of genotype can be attributed to its buffering capacity and adaptability to diverse environments. Regarding the essential oil content, the check varieties Hisar Anand was most stable with near to unit regression (1.03) and non-significant deviation from regression, however its performance was far below the population mean. Considering the stability parameters for essential oil yield, the genotype NDCor-30 was most stable with near unit regression coefficient (1.0) with non-significant deviation from regression; however its performance was far below the population mean. The study showed that no genotype was stable for all the important traits viz., grain yield and essential oil content and yield. Varied response of genotypes to environments in coriander was reported by Uzun *et al*. (2012) and Verma *et al*. (2014). Sastry *et al*. (1989) reported that both predictable and unpredictable components contributed significantly towards the differences in stability of lines for various characters in coriander. Singh and Shah (2003) reported that stability of the genotype along with mean performance should be considered for robust selection of genotypes.

Conclusion: The genotype LCC-236 was superior in yield and quality over other genotypes. The superiority of this genotype may be attributed to its wide adaptability, precocity and robust growth under rainfed conditions. Hence, the genotype may be recommended for cultivation in rainfed vertisols under diverse geographical situations.

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