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Evaluation of Genotypes of Black Pepper (*Piper nigrum* L.) for Yield and Yield Attributes

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Abstract

Black pepper (*Piper nigrum* L.), the king of spices is the most important export-oriented commodity and foreign exchange earner among the Indian spices. Genetic variation and relationship between yield and yield linked characters were studied in five black pepper genotypes. Analysis of variance indicated highly significant differences for all the characters studied. Maximum GCV and PCV were noted for number of spikes plant^{-1} followed by dry berry yield vine^{-1} and fresh berry yield vine^{-1}. High heritability and genetic advance over mean of these traits indicate additive gene effect in the expression of these characters. Dry berry yield plant^{-1} had a very strong correlation with green berry yield vine^{-1} and dry recovery. Genotype Kumpukkal was found promising for various economically significant features. Pepper Thekken exhibited branching spikes compared to other genotypes.

Key words : *black pepper, correlation, field evaluation, heritability, yield.*

Introduction

World's most significant spice, black pepper (*Piper nigrum* L.), originated in humid tropical forests of Western Ghats of South India and is now grown in more than 25 nations. Indian pepper is favoured all over the world because of its inherent properties. Selection from wild over the years has produced cultivars with varying morphology and yield (1, 2, 3). The main gene pool for black pepper is made up of landraces, natural mutants, improved cultivars, and even true seedlings (4). For the production of superior pepper cultivars, a variety of breeding techniques, including clonal selection, open pollination and hybridization have been used. Morphological and qualitative features have been found to vary within or between cultivars and varieties (5). The species' potential for sexual reproduction together with vegetative propagation has significantly contributed to the conservation of variability. The high levels of population diversity have been attributed due to polyploidy, which has been found in a few populations.

India is facing stiff competition from other producing nations in the production of black pepper.It is an immediate necessity to boost production per unit area by utilising improved varieties along with appropriate management practices. New genotypes are also required in addition to raising productivity to prevent genetic vulnerability. As a result, developing superior varieties in black pepper has been a national initiative. Black pepper genotypes identified and developed by farmers are also having importance in the crop improvement. The present study was done with the objective of assessing the genetic variation in three genotypes identified by farmers, one released variety viz., Panniyur 1 and one local cultivar viz., Karimunda and also to identify superior genotypes for dry berry yield and yield attributing characters.

Materials and Methods

The current experiment was conducted at the Pepper Research Station Panniyur (12°081136N 75°399096E), Kannur, Kerala, India. The study materials comprised of five genotypes including three genotypes identified by farmers, released variety Panniyur 1 and local cultivar Karimunda (Table-1) planted during 2015. Panniyur 1 and Karimunda were the control varieties in the experiment. Three replications of the experimental material, each containing six plants, were planted in a Randomized Block Design. The plants were grown in accordance with the recommended package of practices. Data on six quantitative characters viz. length of spike (cm), number of berries spike^{-1}, number of spikes plant^{-1}, fresh berry yield plant^{-1} (kg), dry berry yield plant^{-1} (kg) and dry recovery (%) were recorded during 2021-22. Coefficient of variation, heritability in broad sense (h^2_{bs}), genetic advance, correlation coefficients and analysis of variance (ANOVA) were assessed utilizing the GRAPES software developed by Kerala Agricultural University, India.

Results and Discussion

All the black pepper genotypes differed significantly for the investigated characters (Table-2). The significant difference shows high variability in the genotypes with regard to the characters studied showing the presence of sufficient usable variation. The effectiveness of a crop improvement programmeis dependent upon the amount of genetic variability present in a crop (6). Spike length varied from 9.77 cm to 12.80 cm, number of berries/spike

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Table-1 : List of black pepper genotypes.

Sl. No.	Name of genotype	Remarks
1.	Zion mundi	Farmer's genotype
2.	Pepper Thekken	Farmer's genotype
3.	Kumpukkal	Farmer's genotype
4.	Panniyur 1	National check
5.	Karimunda	Local check

Table-2 : ANOVA for berry yield and its components in black pepper genotypes.

Sources of variation	DF	Mean squares for each character					
		Spike length (cm)	No. of berries/spike	No. of spikes/ plant	Fresh berry yield (kg)	Dry berry yield (kg)	Dry recovery (%)
Replication	2	0.48	30.97	11924.47	0.05	0.01	0.409
Treatment	4	5.61*	110.05*	75709.57*	0.23*	0.04*	28.59*
Error	8	0.625	16.055	6480.47	0.016	0.002	0.305

*Significant at 5% level.

Table-3 : Range, mean, genotypic and phenotypic variance components, heritability and genetic advance for different characters in black pepper genotypes.

Character	Range	Grand mean	SE±	Genotypic variance	Pheno-typic variance	Environ mental variance	Coefficient of variation		Heritability % (H)	Genetic advance (%)
							GCV	PCV		
Spike length (cm)	9.77–12.80	11.48	0.46	1.66	2.29	0.63	11.23	13.18	72.70	19.73
No. of berries/spike	25.33–39.43	33.37	2.31	31.33	47.39	16.05	16.77	20.63	66.10	28.09
No of spikes/plant	205.33–604.00	432.73	46.48	23076.37	29556.83	6480.47	35.11	39.73	78.10	63.90
Fresh berry yield/plant (kg)	0.67–1.35	1.15	0.07	0.07	0.09	0.02	23.10	25.61	81.40	42.93
Dry recovery (%)	29.90–37.80	32.69	0.32	9.43	9.73	0.31	9.39	9.54	96.90	19.05
Dry berry yield/plant (kg)	0.21–0.51	0.38	0.02	0.01	0.01	0.00	28.28	30.60	85.40	53.82

25.33 to 39.43, number of spikes/plant 205.33 to 604.00, fresh berry yield 0.67 to 1.35 kg, dry recovery 29.00 to 37.80% and dry berry yield 0.21 to 0.51 kg (Table 3). Maximum range was observed for number of spikes plant^{-1} followed by number of berriesspike^{-1}. Genotypic variance varied from 0.01 to 23076.37 and phenotypic variance ranged from 0.01 to 29556.83. The phenotypic and genotypic variations were dissimilar from one another, demonstrating the strong environmental influence on morphological features. PCV was generally more in magnitude than GCV for all the characters under consideration, which has shown the impact of environmental factors on yield and the yield contributing traits. However, GCV and PCV values were close to each other for characters like dry recovery (9.39 and 9.54), spike length (11.23 and 13.18), fresh berry yield (23.10 and 25.61) and dry berry yield (28.28 and 30.60). This indicates very low influence of environment in the phenotypic expression of these traits. The number of spikes per plant had the highest GCV and PCV (35.11 and 39.73) followed by dry yield of berry vine^{-1} (28.28 and 30.60) and fresh yield of berry vine^{-1} (23.10 and 25.61). Minimum values of GCV and PCV were recorded for dry recovery (9.39 % and 9.54 %) followed by spike length (11.23 and 13.18). (7, 8, 9) reported wide variation in the per plant yield.

All the characters in this study, exhibited high heritability. The estimates of broad sense heritability ranged from 66.10 % (number of berries/spike) to 96.90 % (dry recovery %). Heritability estimates combined along with genetic advance increase the reliability of a character to selection (10). When the two estimates were compared, number of spikes plant^{-1} (78.10 and 63.90), dry berry yield vine^{-1} (85.40 and 53.82) and fresh berry yield vine^{-1} (81.40 and 42.93) exhibited high heritability accompanied by high genetic advance. Thisindicate additive effect of gene in the characters' expression and can be viewed as a positive attribute. When additive genes are less influenced by environment, phenotypic selection of the characters will be effective (11). (12) observed that rachis weight vine^{-1}, fresh berry yield vine^{-1}and dry berry yield vine^{-1} exhibited high heritability accompanied by high genetic advance. (13) also observed a high genetic advance over mean for economic yield in black pepper. (8) observed high heritability combined high genetic advance for vine column height, spike length and leaf width.

Correlation coefficients suggested that dry berry yield had very strong correlation with green berry yield and dry recovery (Table-4). Number of berries spike^{-1}exhibited strong correlation with number of spikes

Table-4 : Correlation coefficients among different characters in black pepper genotypes.

Character	Spike length (cm)	No. of berries/ spike	No of spikes/ plant	Fresh berry yield/plant (kg)	Dry recovery (%)	Dry berry yield/plant (kg)
Spike length (cm)	1.000					
No. of berries/spike	0.399	1.000				
No. of spikes/plant	-0.002	0.613*	1.000			
Fresh berry yield/plant (kg)	0.477	0.498	0.293	1.000		
Dry recovery (%)	-0.285	0.17	0.289	0.48	1.000	
Dry berry yield/plant (kg)	0.269	0.418	0.323	0.953***	0.715**	1.000

*Significant at 5 % level, **Significant at 1 % level and ***Significant at 0.1 % level.

Table-5 : Comparison of genotypes for economically important characters.

Sl. No.	Treatment	Spike length (cm)	No. of berries/ spike	No of spikes/ plant	Fresh berry yield/plant (kg)	Dry recovery (%)	Dry berry yield/plant (kg)
1.	Zion Mundi (T1)	12.13^{a}	38.03^{a}	476.33^{ab}	1.18^{a}	29.90^{c}	0.35^{b}
2.	Pepper Thekken (T2)	9.77^{b}	25.33^{c}	344.33^{bc}	0.67^{b}	30.67^{c}	0.21^{c}
3.	Kumpukkal (T3)	10.27^{b}	35.20^{ab}	533.67^{a}	1.35^{a}	37.80^{a}	0.51^{a}
4.	Panniyur1 (T4)	12.80^{a}	39.43^{a}	604.00^{a}	1.26^{a}	32.73^{b}	0.41^{b}
5.	Karimunda (T5)	12.43^{a}	28.87^{bc}	205.33^{c}	1.27^{a}	32.33^{b}	0.42^{b}
	CD (0.05)	1.49	7.54	151.57	0.234	1.04	0.08
	CV %	6.89	12.07	18.60	10.91	1.69	10.79

plant^{-1}. Reports by (8, 12) indicated that fresh yield and dry yield had positive and significant correlation in black pepper. In hot pepper, (14) suggested thatdry fruit yield per plant had a significant and positive correlation with number of fruits and fresh fruit yield plant^{-1}. Length of spike was negatively corelated with number of spikes plant^{-1} and dry recovery. (12) also noted that dry recovery had a negative correlation with the length of leaf, leaf petiole and lateral branch, leaf width, setting percentage, test weight, rachis weight, fresh berry yield vine^{-1} and dry berry yield vine^{-1}in black pepper.

Economically important characters of genotypes studied are shown in Table 5. All the genotypes of black pepper varied significantly in length of spike, number of berries per spike, number of spikes per plant, fresh yield, dry recovery and dry yield. For dry berry yield and dry recovery, Kumpukkal (0.51 kg, 37.80 %)was found superior to all other genotypes followed by the local check Karimunda (0.42 kg, 32.33 %) and Panniyur 1 (0.41 kg, 32.73 %). Kumpukkal recorded highest fresh berry yield of 1.35 kg/vine which was on par with, Karimunda (1.27 kg/vine), Panniyur 1 (1.26 kg/vine) and Zion mundi (1.18 kg/vine). Panniyur 1 recorded highest spike length of 12.80 cm which was on par with Karimunda (12.43 cm) and Zion mundi (12.13 cm). Panniyur 1 recorded maximum average number of berries per spike and spikes per plant (39.43, 604.00) which was statistically on par with Zion Mundi (38.03, 533.67) and Kumpukkal (35.20 476.33). After verification of the yield characters of these genotypes under different agro-climatic situations, superior genotypes from farmer's field can be suggested for new variety release.

Pepper Thekken, one of the genotypes of black pepper under investigation, had branching spikes compared to others. (15) reported proliferation of spikes in black pepper and suggested that it could be due to mutation in the floral meristem. A genotype with spike proliferation may lead to production of more berries per spike in addition to its ornamental value.

Significant level of variation for yield characters was found in the five genotypes including three farmers'genotypes, one hybrid and one local check. Maximum GCV and PCV wasnoticed for number of spikes plant^{-1}, dry yield and fresh yield. High heritability and high genetic advance were exhibited for number of spikes plant^{-1}, dry berry yield vine^{-1} and green berry yield vine^{-1}. Dry berry yield was highly correlated with fresh berry yield and dry recovery. Number of berries spike^{-1}have shown positive and significant relation with number of spikes plant^{-1}. Genotype Kumpukkal was found promising for various economically significant characters. Pepper Thekken had branching spikes compared to other genotypes.

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