STABILITY ANALYSIS OF TURMERIC (*Crucuma longa* L.) GENOTYPES FOR RHIZOME YIELD IN NEPAL

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ABSTRACT

The yield evaluation trials were conducted during turmeric growing seasons (summer), 2004 to 2010 comprising local selection cultivars of turmeric over two diverse conditions, both lower altitude (181 masl) and mid hills (1480 masl), to assess the high yielding cultivars of turmeric. Joint regression analysis model was used to determine stability parameters where in mean rhizome yield of the trails was used as independent and individual genotype rhizome yield as dependent variables. The cultivar CI 9801 was found to be most ideal with greater mean rhizome yield than overall mean (27.83 mt $^{-ha}$), statistically unit regression (b=1.175) and lowest deviation from regression followed by CI 9804 which yielded higher and found to be above average, stable and adapted to poor environments. The cultivar CI 0209 recorded top yield (34.05 mt $^{-ha}$) and more specifically adapted to favorable environments (b=1.313).

Key words: stability, turmeric, rhizome yield, regression analysis.

INTRODUCTION

Turmeric (*Curcuma longa* L), Zingiberaceae, is perennial but grown as annual, an important rhizomatous spice as well as medicinal plant with the wide genetic variability with regard to growth and yield which thrives well at lower altitude to higher elevation up to 1600 masl and also under rainfed conditions. Turmeric is grown in Nepal from Terai to Mid hills but limited to 4325 ha of land and production was 35,351 mt of fresh turmeric with the productivity of 8.17 mt $^{-ha}$ in 2011/12 in the country (ABPSD, 2012). Turmeric is commonly grown comparatively in a marginal and smaller piece of land with minimum care in turmeric growing area; however, in the recent years, some of the farmers are growing local turmeric as commercial crop because of not getting improved variety. Up to now improved variety is not released for commercial cultivation. At present, both the production and productivity of turmeric is low because of unavailability of high yielding variety, poor crop management practices, lack of awareness among cultivators, long crop duration, lower priority and processing difficulties. There is ample opportunity of increasing both the production and productivity of turmeric in Nepal with the development of suitable variety and adoption of appropriate production technology.

The ultimate aim of crop improvement program is to develop varieties superior to the existing ones in yield, disease and insect resistance and other quality parameters. High yielding and better stability, high turmeric powder recovery, high curcumin content and wider adaptability are the requirements needed to select a superior turmeric variety. Varietal adaptability to environmental fluctuations is important for the stabilization of crop production both over locations and years. The phenotypic yield performance of any genotype mainly depends on the environmental interaction. Hence, an attempt was made to identify high yielding and stable genotypes of turmeric based on mean rhizome yield and their stability.

MATERIALS AND METHOD

The yield evaluation trials were conducted during turmeric growing seasons (summer), 2004 to 2010, comprising seven local selection cultivars of turmeric over two diverse conditions : both lower altitude at RARS Nepalgunj (181 masl) and mid hills at NGRP, Kapurkot (1480 masl) to evaluate the yield performance of cultivars of turmeric in RCB design with three replications. The plot size was 4.5 m^2. The rhizome yield of seven selected turmeric genotypes (CI 9701, CI 9801, CI 9803, CI 9804, CI 9807, CI 9808, CI 0209) from germplasm evaluation trial in the process of varietal investigation in yield evaluation trials over five years (2004, 2005, 2006, 2007, 2010) were used in this analysis. The stability analysis was carried out by following the model of Finley and Wilkinson (1963) as described by Dabholkar (1999) and Singh (1995). The mean rhizome yield of the evaluated genotypes for a given location and year was considered as trial mean. The trial mean was used as the independent variable and the individual genotype yield was used as the dependent variable. Joint regression analysis was used to determine the performance of genotype in different environments over the respective environmental means. In this model, a regression coefficient (b) of unity indicate average stability, greater than unity means below average stability, and less than unity means the genotype has a greater resistance to changes in environment and possesses above average stability. The coefficient of determination R^2 was also used to determine the level of confidence.

The scatter graph plotted with regression coefficient (b) and genotype mean yield ($\bar{X}$) was also used for describing the stability analysis (Dabholkar, 1999). Observed mean yield of given genotype is plotted against its b value. The vertical line on this graph represents the b values and the horizontal line denotes the mean yield. This graph also helps in selecting genotypes for all, low and high yielding environments.

RESULTS AND DISCUSSION

Stability parameters of seven turmeric genotypes with mean rhizome yield are presented in Table 1. An ideal genotype may be characterized as having the highest mean yield, unit regression (b=1.0), the lowest deviation from regression (SE = 0) and the highest coefficient of determination. Furthermore, the varieties exhibiting high regression coefficient (b>1) could be considered as below average stable varieties. Such varieties will perform well only in favourable environments while their performance will be poor in unfavourable environments. Likewise, the varieties with low regression coefficient (b<1) are above average stable and are adapted specifically to poor environments. The estimates of regression coefficient (b) measures the linear response of individual cultivar to an environmental index, where as SE refers to deviation from the parameter of response (b).

The genotypes CI 0209, CI 9801, CI 9804 had above average mean performance (Table 1). The regression coefficient (b) was highly significant with range of 0.88 to 1.22 for only three genotypes and coefficient of determination (R^2) ranged from 52.4 to 96.9 %. The population mean rhizome yield was 26.67 mt $^{-ha}$ and varietal mean rhizome yield ranged from 22.49± 3.34 to 34.05 ± 5.26 mt $^{-ha}$. Among tested genotypes CI 9801 was the most ideal as having higher mean yield, statistically unit regression and lower SE (0.146) where as the regression coefficient (b) of CI 9808, CI9701 showed less than unity (0.41-0.88) and mean rhizome yield lower than population mean. This indicates that these showed greater resistance to environmental changes and posses above average stability. Genotype CI 0209 has shown higher yield than overall mean and regression value > 1 (1.313) suggested thereby its suitability to the favourable environments and poorly adopted. Among the tested genotypes, CI 9804 possessing higher yield than the overall mean and less than unit regression value was specifically adopted to poor environments; however, its level of confidence is lower (R^2=75.5%).

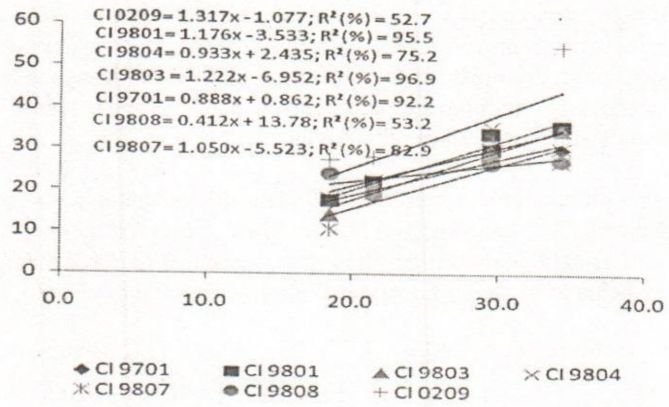
Table 1: Mean rhizome yield and estimate of stability parameters in turmeric genotypes.

Genotypes	Mean Yield ± SEM	Yield range, mt $^{-ha}$	R^2 (%)	b	SE of b
CI 9701	24.56±2.68	17.73 - 30.10	92.3	0.888*	0.148
CI 9801	27.83±3.49	17.55 - 35.70	95.5	1.175*	0.146
CI 9803	25.65±3.60	14.15 - 34.90	96.9	1.221*	0.127
CI 9804	27.32±3.12	18.07 - 35.38	75.5	0.934	0.307
CI 9807	22.49±3.34	10.70 - 28.28	83.1	1.051	0.273
CI 9808	24.78±1.64	18.76 - 27.65	53.3	0.412	0.223
CI 0209	34.05±5.26	27.38 - 54.80	52.4	1.313	0.722
Grand mean	26.67				

* and **, significant at P =0.05 and P = 0.01 respectively.

The superiority of CI 9801 is also shown by the trend line (Fig. 1) which is consistently at a higher level compared to others except CI 0209 in all environments sampled. The trend line of CI 9801, CI 0209 showed that the rhizome yield of these genotypes is about the same as the highest yielder CI 0209 in average yielding environment but their yields does not decrease in low yielding environment in comparison to CI 0209. The trend line also indicates that CI 9808 gave lower mean yield but consistently produced good yield in poor environments also.

Genotype mean yield, mt $^{-ha}$



Trial mean yield, mt $^{-ha}$

Fig. 1: Stability analysis of turmeric across two (mid hill and terai) environments and five growing seasons)

CONCLUSIONS

Cultivar CI 9801 was found to be most stable with greater mean rhizome yield (27.83 mt $^{-ha}$), statistically unit regression (b= 1.17), the lowest deviation from regression (SEb=0.146) followed by CI 9804 which yielded higher yield (27.32 mt $^{-ha}$) and found to be above average stable (b=0.93) and adapted to poor environments. Cultivar CI 0209 recorded the highest yield (34.05 mt $^{-ha}$) and more specifically adapted to favorable environments (b=1.131).

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