Journal of Biotechnology and Crop Science
5(7): 92-95, 2016

A study of prolificacy through mass selection in maize for Northern-Western Himalayas

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Received: 15 September 2016 Revised Accepted: 17 November 2016

ABSTRACT

Results of five generations of selection for improved productivity in corn by selecting for prolificacy, a correlated trait, are reported. The regression for gain in yield per cycle of selection relative to the cross between N3 x J1. Full-sib and half-sib families, developed in the population using NCD1, were evaluated at experimental fields of Vivekananda Institute of Hill Agriculture Almora (1250 m amsl) using normal and high plant densities. Parental variety compares favorably with a previously reported gain from mass selection in the same variety using weight of grain per plant as the selection trait. The greater effectiveness of selection where prolificacy was the primary trait is believed due to higher selection intensity used as well as higher heritability. The results revealed that additive componants were significant for ears per plant (Prolificacy), ear diameter, kernel rows per ear, 100 kernel weight, ear grain weight and total grain yield. Heritability and expected genetic gains were highest for ear grain weight followed by total grain yield and ears per plant.

Key Words: *Maize, Prolificacy, Selection genetic variance*

INTRODUCTION

Crop species underwent profound transformations in morphology during domestication. Among crops, maize experienced a more striking change in morphology than other crops. Among the changes in maize from its ancestor, teosinte, was a switch from 100 or more small ears per plant in teosinte to just one or two large ears in maize. We show that this change in ear number has a relatively simple genetic architecture involving a gene of large effect, called *grassy tillers1*. Moreover, we show that *grassy tillers1* experienced a tissue-specific gain in expression in maize that is associated with suppressing the initiation of multiple ears per plant such that only one or two large ears are formed. Prolificacy (ears per plant) has been widely recognized as most important character, due to relatively high positive correlation with grain yield (Goodman 1966, Burn and Dudley 1989, Burk and Magoja 1990). Prolificacy is also desirable to increase grain production at high densities, particularly under high soil fertility and moisture (Collins *et al* 1965, Russell 1968). Leng (1964), Lindsey *et al* (1962) reported partial dominance, with prevalence of additive genetic variance for prolificacy. Effects of complete dominance and over-dominance have also been reported (Laible and Dirk 1968). A high heritability of the character has been reported by several workers including Leng (1954) and Laible and Dirk (1968). The studies conducted to estimate the effects of plant densities on genetic components in prolific or semi-prolific types, however, in most of the cases are based on relatively lower densities (Subandi and Compton 1974, Sorrels *et al* 1979) than the recommended level (60,000-65, 000 plants/ha) in our country.

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MATERIALS AND METHODS

The present study was undertaken with North Carolina Design I (NCD I) to estimate genetic component of variance in a prolific base population at normal and high plant densities. We developed material comprised 202 full-sib and half sib families developed using NCD1 in a broad base one generation advance population of a cross between N3 (A highly prolific collection from North-east Himalyas) and composite J_1.

RESULTS AND DISCUSSION

The usually greater effectiveness of selection for prolificacy in increasing productivity is due to the greater selection intensity applied. Mass selection based upon weight per plant has been subjected to a selection intensity of l0%. Prolific selection has undergone a selection intensity of about 5%. The first type of selection is much simpler and the trait is less affected by environmental variation. Thus with less effort a larger number of plants can be observed in selecting the desired total harvested sample. Prolificacy may be indicative of greater plant vigor. Moreover, two or more years on the main culm may allow for greater photosynthetic efficiency since there should be less congestion in the movement of photosynthetic from the leaf areas to the storage organs (ears). Also in prolific plants, any impairment of movement in a given shank region because of insect damage or disease provides alternate pathways for continued movement to the starch deposition regions (ears).The increase in tillering in plants selected for prolificacy is also an indication of plant vigor. They can contribute to productivity, however, where they produce grain. Problems with increased lodging on the part of grain bearing tillers may exist, however, although there is reason to believe this problem can be overcome by selection for greater stalk strength. Prolificacy is an effective breeding tool. The development of several ears on each plant can provide the breeder with what becomes an approach to a multi flowered plant, not in a strict sense of the word but at least an important deviation from the single eared type. This modification permits the utilization of mating systems not previously utilized. Since the gain in yield through selection for prolificacy is rather substantial the opportunities for simultaneous selection for other important agronomic traits seems good. Improvement in yield will be of little interest if other important attributes are ignored. In the present study, negative and non-significant estimates of dominance variance indicated that there was no overestimation of dominance variance and hence multiple allelism can be assumed to be absent. Estimates of genetics variance (Table 1) indicate prevalent role of additive component in case of prolificacy and other traits, except ear length in normal and high plant densities. Magnitude-wise also the additive component was larger in high density (E_2) than in normal (E_1) for all the traits. Preponderance of additive components revealed that both environments (E_1 and E_2) were suitable for selection; however, E_2 appeared to be more favorable. Shahi and Singh (1988) has also suggested more importance of additive variance under high plant population. Significant additive variance has also been reported by Robinson *et al* (1949) for prolificacy and grain yield, Khehra *et al* (1985) for grain yield, ear length and kernel rows per ear; Shahi and Singh (1985) for grain yield, ear length, ear diameter, kernel rows per year and 100 kernel weight; Ochieng and Compton (1994) for ears per plant. In the present investigation, dominance variance was found to be negative for ears per plant, and ear diameter in E_2 and for 100 kernel weight in both environments. As the variance by definition cannot be negative, therefore, true value for these estimate may be either zero or of small positive value. These negative estimates might have resulted due to sampling error or lack of random mating in making half-sib groups. In the present investigation, dominance variance was found to be negative for ears per plant, ear diameter in E_2 and for 100 kernel weight in both E_1 and E_2. The magnitude of dominance variance for the remaining traits was quite low itself and also lowers than the corresponding additive component. Under high plant population, the estimates of dominance variance were higher than the corresponding estimates under normal plant populations for ear length and ear grain weight, however, kernel rows per ear and total grain yield showed comparatively more dominance variance under normal plant populations. The results, therefore, indicated that dominance variance had no role in the inheritance of all the traits at both density level. Heritability in narrow sense (Table 2) for prolificacy and other traits resulted from very low for ear length to considerably high for ear grain weight with slightly higher estimates in E_2 than E_1. First ear grain weight recorded substantially higher score of heritability than the total grain yield and prolificacy at both densities. Expected gains through full-sib and mass selection were highest for first ear grain weight in E_1 and E_2. Prolificacy and total grian yield showed substantial expected improvement throught full-sib and mass selection at both the densities. Magnitude of gain was higher in E_2 for ear kernel rows, ear grain weight, however, ear length and total grain yield recorded comparatively high expected gain in E_1 than E_2. Full-sib selection surpassed mass selection by 2 to 4 times in expected gains per cycle of selection (Table 2).

The results of the present investigation therefore, indicated that high plant density is more desirable for expression of additive variance than normal plant densities, and substantial improvement can be made for all the traits except ear length and total grain yield. Mass selection or recurrent selection scheme of population improvement capitalizing on additive genetic variance and use of high plant density environment may be more fruitful for a realistic improvement in prolific materials. The use of a correlated secondary character as the primary trait in selection (ears per plant) to improve the character of interest (yield) has been termed indirect selection (Falconer 1960). It has been pointed out that indirect selection may be more effective if the secondary character has a substantially higher heritability and the genetic correlation between the two is high. The possibility of being able to apply substantially higher selection intensity to the secondary character is also a critical factor. The character ears per plant can be measured with precision, Yield, on the other hand, is highly subject to environmental variations, and differences in moisture content may be a more serious influence on weight differences than is commonly realized. As Falconer (1960) points out, the most effective progress may be obtained where both the desired and the secondary character are used in combination. Although grain weights were not taken in the present study, attention was given to apparently higher grain yields in the prolific plants selected. It would seem that a component of yield which can be measured with less work and error (ears per plant) than the primary trait (yield) and which is highly correlated with the primary trait will be useful as an aid to improvement in yield.

REFERENCE

Burk R, Magoja JL (1990) Yield and yield components of full sib and half sib families derived from a perennial teosinte introgressed populations. Maize Genetics Cooperation News Letter No. 64: 76.

Burn EL, Dudley JW (1989) Breeding potential in USA and Argentina of corn populations containing different proportion of flint and dent germplasm. Crop Sci 29: 570-577.

Collins WK, Russell WA, Eberhart SA (1965) Performance of two ear type of cornbelt maize. Crop Sci 5: 113-116.

Comstock RE, Robinson HF (1948) The components of genetic variance in populations of biparental progenies and their use in estimating vaverage degree of dominane. Biometrics 4: 254-266.

Elshire RJ, Glaubitz JC, Sun Q, Poland JA, Kawamoto K (2011) A robust, simple genotyping-by-sequencing (GBS) approach for high diversity species. PLoS ONE 6: e19379.

Falconer DS (1960) Introduction to quantitative genetics. New York: The Ronald Press.

Goodman MM (1965) Estimation of genetic variance in adapted and semi-extotic population of maize. Crop Sci 5: 87-90.

Hallauer AR, Miranda JB (1981) Quantitative Genetics in Maize Breeding. Iowa State Univ Press, Ames.

Khehra AS, Malhi NS, Pal SS (1985) Estimates of genetic parameters in an open pollinated variety of maize. Crop Imp 12: 137-140.

Laible AL, Dirk VA (1968) Genetic variance and selective ear number in corn (*Zea mays* L.). Crop Sci 8: 540-543.

Leng ER (1954) Effects of heterosis on the major components of grain yield in corn. Agron J 46: 502-506.

Lindsey MF, Lonnquist JH, Gardner CO (1962) Estimates of genetic variance in open-pollinated varieties of corn-belt corn. Crop Sci 2: 105-108.

Ochieng JAW, Compton WA (1994) Genetic effects from full-sib selectionin Krug maize (Z. mays L.). J Genetics & Plant Breeding 48(2): 191-196.

Robinson HF, Comstock RE, Harvey PH (1949) Estimates of heritability and degree of dominance in corn. Agron J 41: 353-359.

Robinson HF, Comstock RE, Harvey PH (1955) Genetic variance in open pollinated varieties of corn. Genetics 40: 45-60.

Russel WA (1968) Test cross of one and two ear types of corn belt maize inbreds. I. Performance at four plants densities. Crop Sci 8: 244-247.

Shahi JP, Singh IS (1985) Estimation of Genetic variability for grain yield and its components in random mating population of maize. Crop Improv 12: 126-129.

Shahi JP, Singh IS (1988) Genetic variability in maize composite. Crop Improv 15: 101-104.

Whipple CJ, Kebrom TH, Weber AL, Yang F, Hall DH *et al.* (2011) *grassy tillers1*promotes apical dominance in maize and responds to shade signals in the grasses. Proc Natl Acad Sci USA 108: e506–e512.