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Heterosis for Dry root yield and Alkaloid content in Genotypes of Ashwagandha (*Withania somnifera* L. Dunal)

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ABSTRACT

Increases in root yield and alkaloid content are still desired today. Line breeding was traditionally used to enhance total alkaloid content with the aim of outcrossing inbred lines to develop a synthetic variety. We wanted to see whether and also how much heterosis in ashwagandha could be exploited. We evaluated 15 parental lines, three testers along with 45 corresponding F1 hybrids developed in a line x tester mating design using a randomized block design with one year of growing and three replications per year. We determined the early flowering, plant height, root length and root diameter, number of secondary and tertiary root per plant, dry root yield per plant and total alkaloid content, grain yield per ear and biological yield per. The hybrids L_5 x T_3, L_9 x T_3, L_{14} x T_3, L_{14} x T_2 for most of characters including days to 50 per cent flowering, plant height, root length and root diameter, number of secondary and tertiary root per plant, dry root yield per plant and total alkaloid content, grain yield per ear and biological yield per plant identified as economic heterosis on pooled basis. The findings give us hope that better annual varieties will be available soon.

Key words : *Solanaceae, Synthetic variety, Heterosis, Correlation, Combining ability.*

Introduction

Since the ancient times, humans have depended heavily on plants to meet their health requirements. More than 80,000 of the 2,50,000 higher plant species on the planet are medicinal in nature. Root, wood, bark, whole plant, fruit/seed, flower, or leaf are some of the plant parts used in medicines.

Ashwagandha (*Withania somnifera* L., 2n = 4x = 48) is an evergreen perennial shrub that grow in India, the Middle East and parts of Africa (Nigam and Kandalkar, 1995). The economic part of shrub is roots that are widely used in lot of ayurvedic formulation, pharmaceutical product and herbal products which enhance immunity. They contain total alkaloid content, which mainly consists of ashwagandhine, cuscohygrine, anahygrine, tropine with anolides (Zhao *et al.*, 2002). The roots of Ashwagandha are high in demand both domestically and globally. There is a need to popularize its cultivation in India as a consequence of rising demand. Therefore, total alkaloid content is the major quality trait in ashwagandha breeding. Nevertheless, breeders and farmers focus on appropriate seed yields. In many crops, yields were substantially improved by exploiting heterosis. However, an efficient system to control pollination, which would be necessary for hybrid breeding. In this study as a con-

secutive step, we wanted to detect whether and to what extent heterosis can be exploited in ashwagandha. In case of success, improved prebred annual material could be available soon. Additionally, we aimed to investigate correlations between traits and heritability of traits. Our findings could support selection decisions in future breeding processes.

Materials and Methods

we used inbred material in the fourth and fifth inbred generation that originated from crossings between biennial material. The material was selected for early maturity and high total alkaloids content. In 2019, 15 inbred lines were crossed with 3 testers using line x tester mating design (Kempthorn, 1957), to produce 45 corresponding F_1 populations for GCA testing.

The GCA test was carried out at the all three locations (Udaipur, Badgaon and Banswara) in Humid and Sub-humid Southern Plains of Rajasthan (India) in 2020-21. As integral part of these trials, we also tested the performance of the inbred lines per se. An overview of the material used in the field trials is provided. We used a randomized block design with three replications per genotype and year

Statistics

The data was subjected to ANOVA following the standard procedures. Analysis of variance (ANOVA) of each character was carried out. Different classes of Heterosis i.e., heterobeltiosis and economic heterosis were calculated according respectively. Well known methods (Fonseca and Patterson, 1968) (Meredith and Bridge, 1972). Line x tester analysis was carried out according to Kempthorn (1957).

Results and Discussion

the highest negative and significant estimate of heterosis was exhibited by hybrid L_{10} x T_3 (-13.53 %) in E1, hybrid L_{12} x T_3 (-6.45 %) in E2 and L_{11} x T_3 (-8.14 %) in E3 on pooled basis. The hybrid L_{10} x T_3 exhibited maximum significant negative heterobeltiosis in E1 (-12.41 %), L_6 x T_2 in E2 (-6.16 %) and L_{11} x T_3 in E3 (-7.51) environment. the highest estimate of positive and significant relative heterosis exhibited by hybrids L_{13} x T_3 (45.48 %) in E1 and L_{15} x T_1 in both the environments E2 (26.83 %) and E3 (14.78 %). L_7 x T_3 (66.29 %), showed highest positive and significant heterobeltiosis. the highest positive significant heterosis for root length was showed by hybrid L_8 x T_2 in all the three environments viz., E1 (29.73 %), E2 (25.42 %) and E3 (23.20 %). The highest estimate of significantly positive heterobeltiosis exhibited by hybrid L_8 x T_2 in all the three environments *viz*., (14.29 %) in E1, (15.63 %) in E2 and (11.59 %) in E3. the highest positive significant heterosis for root diameter was showed by hybrid L_6 x T_2 in E1 (91.02 %) and also in E3 (63.89 %), L_8 x T_2 in E2 (65.62 %) environments. Hybrid L_6 x T_2 has exhibited the highest estimate of significantly positive heterobeltiosis in both E1 (85.47 %) and E3 (54.68 %). The maximum values for positive significant heterobeltiosis were observed in hybrid L_9 x T_3 in both the environments E1 (34.02 %) and E2 (35.75 %) and L_6 x T_3 in E3 (43.38 %) environment. The highest heterobeltiosis was exhibited by hybrid L_{14} x T_2 (139.02 %) in E1 and on pooled basis (36.25 %). The hybrid L_{14} x T_2 (7.31 %) showed highest positive and significant economic heterosis over the best check for dry root yield in E1 as well as (12.77 %) over the environments (Table 1). Hybrid L_{14} x T_3 in E1 environment (35.11 %), hybrid L_{13} x T_3 in E2 (41.94 %) whereas L_{14} x T_1 in E3 (41.49 %) environment as well as on pooled basis (26.94 %) manifested maximum positive and significant values for mid parent heterosis for alkaloid content (Table 2). The hybrids L_5 x T_3, L_9 x T_3, L_{14} x T_3, L_{14} x T_2 for most of characters including days to 50 per cent flowering, plant height, root length and root diameter, number of secondary and tertiary root per plant, dry root yield per plant and total alkaloid content, grain yield per ear and biological yield per plant identified as economic heterosis on pooled basis.

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