Correlation Studies in Ashwagandha [Withania somnifera (L.) Dunal]

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Authors’ contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

In the present study entitled “Variability and Correlation Studies in Ashwagandha [Withania somnifera (L.) Dunal]”, 74 genotypes along with three standard checks viz., JA-20 (Jawahar Asgandh-20), JA-134 (Jawahar Asgandh-134) and RVA-100 were evaluated in augmented RBD design during late kharif 2019-20 at the Instructional Farm, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur (Rajasthan).

The observations were recorded on ten randomly selected competitive plants for fifteen characters, viz. days to 50% flowering, days to 75 per cent maturity, plant height, number of primary branches per plant, number of secondary branches per plant, leaf area index, root length, root diameter in collar region, fresh root yield per plant, dry root yield per plant, fresh plant weight per plant, dry plant weight per plant, 100 seed weight, harvest index and total alkaloid. Analysis of variance, correlation coefficient and path analysis were performed for the mean data.

The dry root yield per plant exhibited significant and positive correlation with dry plant weight, fresh root yield and harvest index at both genotypic and phenotypic level. While with, root diameter in

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collar region at genotypic level and fresh plant weight at phenotypic level. Positive and significant correlation among dry root yield per plant and contributing characters would help in indirect selection for dry root yield per plant in the crop like ashwagandha where economic part (dry root yield per plant) remain underground up till uprooting.

Keywords: Ashwagandha; genotypic level; phenotypic level; Analysis of variance; pharmacological effects.

1. INTRODUCTION
Ashwagandha [Withania somnifera (L.) Dunal] generally known as Indian ginseng is likewise named poison gooseberry or winter cherry [1]. Ashwagandha is an angiosperm plant that belongs to the Solanaceae family [2]. It is a self-pollinated plant bearing chromosome no. 2x=48 [3,4], 2x=24 [5], 2x=75 [6]. It is hardy and drought-tolerant perennial plant [7] that develops well in dry and sub-tropical regions having well-drained, sandy loam or light red soils [8] having pH of 7.5 to 8.0 with an average rainfall of 600-750 mm. Two species of Ashwagandha are found in India, viz. Withania somnifera (L.) Dunal (Ashwagandha) and Withania coagulans (L.) Dunal (Panir).

*The pharmacological effects of the roots of W. somnifera are attributed to the presence of withanolides, a group of steroidal lactones. Its leaves are used in Ayurvedic and Unani systems for treatment of tumors and tubercular glands. A number of withanolide steroidal lactones have been isolated from the leaves of W. somnifera and exhibit antibacterial, anti-fungal and antitumor properties.

Ashwagandha is cultivated mainly in Madhya Pradesh, Rajasthan, Gujarat, Maharashtra, Punjab and Uttar Pradesh whereas Withania coagulans (L.) found in wild. It is indigenous to India and is also found in Spain, Egypt, Israel, Jordan, Sudan, Iran, Afghanistan, Morocco, Baluchistan, Pakistan, Sri Lanka, and Mediterranean region of east Africa. It is late kharif crop and grown under dry climate or required less irrigation for plant growth and rainfed cultivation. It is grown between 600-1200 meters altitudes. The semi tropical area receiving 60-75 cm annual rainfall with high temperature 20°C to 35°C is suitable for its cultivation. Ashwagandha is grown on marginal lands of Neemach and Mandsaur district of M.P. and Kota, Jhalawar, Pratapgarh, Chittorgarh and Baran districts of Rajasthan Ashwagandha is an important medicinal plant. Its roots leaves and seeds are used in ayurvedic and unani medicines.

The medicinal utility of roots is due to present of number of alkaloids. The total alkaloids content in the roots varied from 0.16 to 0.66 percent [9]. The plant contains a range of different classes of chemical constituents such as alkaloids, steroidal lactones, and flavonoids. All chemicals listed pertain to the root unless otherwise specified, as the root is the part used.

*The main constituents of ashwagandha are alkaloids and steroidal lactones. Among the various alkaloids, withanine is the main constituent. The other alkaloids are somniferine, somnine, somniferin, withanine, pseudo-withanine, tropine, pseudo-tropine, 3-angeloyloxytropane, choline, cuscohygrine, isopelletierine, anaferine and anahydrine. Two acyl steryl glucoside viz. Sitoindoside VII and sitoindoside VIII have been isolated from root. The leaves contain steroidal lactones, which are commonly called withanolides. The withanolides have C28 steroidal nucleus with C9 side chain, having six membered lactone ring.

The roots are prescribed in medicines for hiccup, several female disorders, bronchitis, rheumatism, dropsy, stomach and lung inflammation and skin disease. Its roots and paste of green leaves are used to relieve joint pain and inflammation. It is also an in gradient of medicaments prescribed for curing disability and sexual weakness in
males. Seeds are diuretic, warm leaves are used for providing comfort during eye disease [10].

*The global interest in this plant and the high demand for its roots provide ample scope to cultivate this plant on commercial scale. Other opportunities for cultivation include: Present price for roots is attractive, crop gives economically remunerative returns in comparison to traditional crops, ease of cultivation under rainfed condition, the crop can be integrated with traditional crops through crop sequencing, opportunities for marketing leaf and seed exist, bye-products can be profitably be utilized, value addition can increase profits, however, current exports are limited and large scale exports of roots and value added products need to be explored.

2. MATERIALS AND METHODS

The present investigation was carried out to which the information “Variability and Correlation Studies in Ashwagandha [Withania somnifera (L.) Dunal]”. The investigation was spread out in late kharif 2019-20 at the Instructional Farm, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur.

*Topographical, Udaipur is situated at 240 -350 N scope and 730 -420 E longitude and at a rise of 582.17 meters above mean sea level.

Field experiment was led to get the genetic variability, correlation coefficient and path analysis among 74 genotypes with three standard checks viz. JA-20, JA-134 and RVA-100 which were evaluated in augmented design. The sound yield seeds of every genotype were planted in single plot of 3 meter length keeping up crop geometry 30 x 5 cm row to row and plant to plant spacing respectively at Instructional Farm, Rajasthan College of Agriculture, MPUAT, Udaipur, during late kharif 2019-20. The recommended packages of practices were followed to raise the healthy crop.

3. RESULTS AND DISCUSSION

The observations were recorded on ten randomly selected competitive plants for fifteen characters, viz. days to 50% flowering, days to 75 per cent maturity, plant height, number of primary branches per plant, number of secondary branches per plant, leaf area index, root length, root diameter in collar region, fresh root yield per plant, dry root yield per plant, fresh plant weight per plant, dry plant weight per plant, 100 seed weight, harvest index and total alkaloid content.

3.1 Correlation Coefficient Analysis

The knowledge of genetic correlation for yield, its components and various quality characters become very important when the breeder is confronted with problem a combing high yield potential with desirable agronomical and quality parameters. Association studies would provide reliable information on nature, extent and direction of selection.

3.2 Correlation among Different Characters

3.2.1 Days to 50 per cent flowering

Days to 50% flowering showed positive and significant correlation with days to 75 per cent maturity (rg = 0.32**), root length (rg = 0.35**) and 100 seed weight (rg = 0.44**) at genotypic level and also showed negative and significant correlation with plant height (rg = -0.27*), root diameter in collar region (rg = -0.30**) and alkaloid content (rg = -0.64**) at genotypic level.

3.2.2 Days to 75 per cent maturity

Days to 75 per cent maturity showed positive and significant correlation with dry plant weight per plant (rg = 0.60** and rp = 0.43**) and fresh plant weight per plant (rg = 0.52** and rp = 0.39**) at both genotypic and phenotypic level. While with fresh root yield per plant (rg = 0.45**), 100 seed weight (rg = 0.26*), at genotypic level. However, days to 75 per cent maturity showed significant and negative correlation with harvest index (rg = -0.51**and rp = -0.25*) at both genotypic and phenotypic level. While with plant height (rg = -0.47**) at genotypic level and with root length (rg = -0.29*) at phenotypic level.

3.2.3 Plant height

The plant height showed positive and significant correlation with root diameter in collar region (rg = 0.21* and rp = 0.36**) at both genotypic and phenotypic level. While with leaf area index (rg = 0.28*) and fresh root yield per plant (rg = 0.30**) at genotypic level. The present findings are in accordance with the findings of Mohsin et al. [11], Yadav et al. [12], Dubey et al. [13], Kubsad et al. [14], Patel et al. [15], Joshi et al. [16], Dev et al. [17], Sundesha et al. [18] and Deeksha [19].
3.2.4 Number of primary branches per plant
The number of primary branches per plant exhibited positive and significant correlation with root diameter in collar region (rg = 0.60** and rp = 0.23*) at both genotypic and phenotypic level. While number of primary branches per plant showed significant and negative correlation with number of secondary branches per plant (rg = -0.43** and rp = -0.33**) at both genotypic and phenotypic level. However, showed significant and negative correlation with fresh root yield per plant (rg = -0.58**), dry plant weight per plant (rg = -0.31**) and alkaloid content (rg = -0.35**) at genotypic level.

3.2.5 Number of secondary branches per plant
The number of secondary branches per plant showed significant and positive correlation with fresh plant weight per plant (rg = 0.30** and rp = 0.25*) at both genotypic and phenotypic level. While with root length (rg = 0.65**) and 100 seed weight (rg = 0.73**) at genotypic level only.

3.2.6 Leaf area
The leaf area index showed significant and positive correlation with fresh root yield per plant (rg = 0.34** and rp = 0.30**) at both genotypic and phenotypic level. While with root diameter in collar region (rg = 0.76**) dry plant weight per plant (rg = 0.25*) and alkaloid content (rg = 0.43**) at genotypic level.

3.2.7 Root length
The root length showed significant and positive correlation with root diameter in collar region (rg = 0.72*), fresh root yield per plant (rg = 0.44**), dry plant weight per plant (rg = 0.61**), fresh plant weight per plant (rg = 0.41**) and harvest index (rg = 0.53**) at genotypic level. The present findings are in accordance with the findings of Yadav et al. [12], Dubey et al. [13], Patel et al. [15], and Sangwan et al. [20].

3.2.8 Root diameter in collar region
The root diameter in collar region exhibited significant and positive correlation with fresh plant weight (rg = 0.21*), 100 seed weight (rg = 0.20*) and dry root yield per plant (rg = 0.72**) at genotypic level. The present findings are in accordance with the findings of Yadav et al. [12], Sangwan et al. [20] and Joshi et al. [16].

3.2.9 Fresh root yield per plant
The fresh root yield per plant exhibited significant and positive correlation with dry root yield per plant (rg = 0.98** and rp = 0.25*) at both genotypic and phenotypic level. However, with harvest index (rg = 0.72**) at genotypic level and with fresh plant weight per plant (rp = 0.23*) at phenotypic level. The present findings are in accordance with the findings of Sangwan et al. [20] and Mishra [21].

3.2.10 Dry plant weight per plant
The dry plant weight per plant exhibited significant and positive correlation with dry root yield per plant (rg = 0.57** and rp = 0.32**) at both genotypic and phenotypic level. While with 100 seed weight (rg = 0.62**) at genotypic level and with fresh plant weight per plant (rp = 0.21*) at phenotypic level.

3.2.11 Fresh plant weight per plant
The fresh plant weight per plant exhibited significant and positive correlation with 100 seed weight (rg = 0.83**) at genotypic level and with fresh plant weight per plant (rp = 0.23*) at phenotypic level.

3.2.12 100 seed weight
100 seed weight per plant showed no correlation with any of the character at both genotypic as well as phenotypic levels.

3.2.12 Harvest index
The harvest index exhibited significant and positive correlation with dry root yield per plant (rg = 0.50**) at genotypic level.

3.2.13 Total alkaloids content
Total alkaloids content showed negative significant correlation with dry root yield per plant (rg = -0.34**) at genotypic level only.

3.2.14 Dry root yield per plant
The dry root yield per plant exhibited significant and positive correlation with dry plant weight per plant (rg = 0.57** and rp = 0.32**), fresh root yield per plant (rg = 0.98** and rp = 0.25*) and harvest index (rg = 0.50** and rp = 0.58**) at both genotypic and phenotypic level. While with root diameter in collar region (rg = 0.72**) at genotypic level and fresh plant weight per plant (rp = 0.23*) at phenotypic level. The present findings are in accordance with the findings of Kailas [22], Kumar et al. [23], Singh [24], Gami et al. [25], Sundesha et al. [18] and Nagar [26].
Table 1. Genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficients between different characters

| SN Character                          | Days to 50% Flowering | Days to 75% Maturity | Plant Height (cm) | Number of Primary Branches per plant | Number of Secondary Branches per plant | Leaf area Index | Root Length (cm) | Root Diameter at Collar region (mm) | Fresh root Harvest 100 Seed (%) | Dry root Yield per plant (g/plant) |
|---------------------------------------|------------------------|----------------------|-------------------|--------------------------------------|---------------------------------------|----------------|------------------|-------------------------------------|---------------------------------|-----------------------------------|
| 1 Days to 50% Flowering              | 0.32**                 | -0.27**              | -0.15             | 0.05                                 | 0.10                                  | 0.35**         | -0.30**          | -0.19                               | -0.03                           | 0.21                              |
| 2 Days to 75% Maturity               | 0.22                   | -0.47**              | 0.11              | 0.06                                 | 0.04                                  | 0.01           | -0.22            | 0.45**                             | 0.60**                          | 0.02                              |
| 3 Plant Height (cm)                  | -0.09                  | 0.00                 | -0.25*            | -0.08                                | 0.28*                                 | 0.69           | 0.21*            | 0.30**                             | -0.08                           | 0.21                              |
| 4 Number of Primary Branches per plant | -0.05                  | 0.10                 | -0.08             | -0.43**                              | -0.09                                 | 0.08           | 0.60**           | -0.58**                            | -0.31**                         | -0.15                             |
| 5 Number of Secondary Branches per plant | 0.02                   | -0.04                | 0.01              | -0.33**                              | 0.23                                  | 0.65**         | 0.08             | 0.01                               | -0.06                           | 0.30**                            |
| 6 Leaf area Index                    | -0.05                  | 0.03                 | 0.09              | -0.07                                | 0.12                                  | 0.76**         | 0.25**           | 0.25**                             | 0.34**                          | -0.91**                           |
| 7 Root Length (cm)                   | 0.02                   | -0.29*               | -0.11             | -0.22                                | 0.11                                  | 0.10           | 0.72**           | 0.44**                             | 0.61**                          | 0.41**                            |
| 8 Root Diameter at Collar region (mm)| -0.07                  | -0.08                | 0.36**            | 0.23*                                | 0.04                                  | 0.19           | -0.06            | -0.30                               | -0.02                           | 0.21**                            |
| 9 Fresh root Yield per plant (g)     | 0.07                   | -0.03                | 0.06              | -0.14                                | 0.02                                  | 0.12           | 0.10             | -0.06                               | -0.11                           | 0.10                              |
| 10 Dry plant weight per plant (g/plant) | 0.14                   | 0.43**               | 0.07              | -0.16                                | -0.00                                 | 0.08           | -0.02            | 0.23*                               | 0.11                            | 0.62**                            |
| 11 Fresh plant weight per plant (g/plant) | 0.07                   | 0.39**               | 0.14              | -0.23                                | 0.25*                                 | 0.30**         | 0.14             | 0.03                               | 0.25*                           | 0.70**                            |
| 12 100 Seed weight (g)               | 0.01                   | -0.19                | -0.10             | -0.12                                | -0.02                                 | -0.01          | 0.06             | -0.00                               | 0.05                            | 0.01                              |
| 13 Harvest Index (%)                 | -0.11                  | -0.25*               | 0.08              | 0.16                                 | -0.04                                 | -0.10          | 0.01             | 0.03                               | 0.03                            | -0.53**                           |
| 14 Total Alkaloid content (%)        | -0.22                  | -0.05                | 0.10              | -0.21                                | 0.01                                  | -0.08          | 0.03             | -0.01                               | 0.08                            | -0.04                            |
| 15 Dry root Yield per plant (g)      | -0.01                  | 0.17                 | 0.16              | 0.04                                 | -0.03                                 | 0.02           | 0.02             | 0.25*                               | 0.32**                          | 0.23*                             |

* & ** Significant at 5% & 1% respectively
4. CONCLUSION

From the above results, it is concluded that the material assessed in the present investigation possessed wide range of variation for various characters. Positive and significant correlation among dry root yield per plant and contributing characters would help in indirect selection for dry root yield per plant in the crop like ashwagandha where economic part (dry root yield per plant) remain underground up till uprooting.

NOTE

The study highlights the efficacy of “ayurvedic” which is an ancient tradition, used in some parts of India. This ancient concept should be carefully evaluated in the light of modern medical science and can be utilized partially if found suitable.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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