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Impact of different seed rates with planting methods on root shoot ratio of ashwagandha (*Withania somnifera*)

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Abstract
The experiment will be conducted in the summer of 2021 at KSG Akal Faculty of Agriculture, Eternal University, Baru Sahib (H.P.). The experiment included two factors (seed and cultivation method), eight treatment combinations were prepared and placed in 3 different fields in the FRBD to obtain stable results and conflict. Including two different seeding rates (S) (S1-4 kg ha^{-1}, S2-5.5 kg ha^{-1}) and four sowing methods (M) (M1-broadcast, M2-stranded, M3-random pass) combination of eight applications, M4-line switch). The results showed that the poor development of the cultivars was determined by the seed difference and recorded a maximum of 5.5 kg^{-1}. It has been confirmed that a higher root-to-stem ratio has been reported in the M3 treatment (transplantation). The data were not significantly affected by the effect of seed on root-to-stem ratio at different stages. Regarding the intervention, the root-to-plant ratio is reported as treatment M3S2, i.e transplant + 5.5 kg per hectare.

Keywords: Ashwagandha, planting methods, root ratio, shoot ratio, seed rates, transplanting

Introduction
The Indian Himalayan region (IHR) is a hotspot for plant bio diversity, with a high number of medicinal plants that are used in the Himachal Pradesh Agriculture model to diversify crops. Himachal Pradesh's biodiversity is under a great deal of stress because of the rising demand for natural health care products for commercial use. Withania somnifera, often known as ashwagandha, is a well-known medicinal herb because it contains withanine and alkaloids. In order to boost production in the hill land agriculture of Sirmour district (H.P), scientists must pay special attention to the cultivation technology of this herbal plant.

Experimental research have also shown that the ashwagandha plant contains active withanolides and alkaloids, which have medicinal characteristics that can be used in ayurvedic and yunani medicines to boost brain processes and the memory system. The plant's roots contain an alkaloid that has anti-cancer, anti-tumor, and antibacterial activities. To treat joint pain and inflammation, a paste made from the plant's green leaves and roots is employed. The leaves themselves are often used to calm those with eye disorders. Additionally, it supports human reproduction and its balances.

With a demand of 7000 tonnes per year, the projected yearly production of ashwagandha in India is just about 1500 tonnes. The need to develop the appropriate technology to close the production gap has become crucial for agronomists working on this herbal crop (Anonymous, 2009). According to recent research studies, the main factors limiting this crop's poorer yields in the nation include its shy germination, inadequate planting techniques, and various environmental circumstances (Raghuveer, 2019) [6].

The Sirmour district is located in Himachal Pradesh's mid-Himalayan area, which has unusual weather patterns like erratic rainfall and chilly temperatures in the winter. The area's topography is sloppy, uneven, and dangerously prone to erosion. Another barrier to achieving the ideal plant population is the seed's poor intrinsic behaviour for germination. It is necessary to determine the seed rate per unit area and adopt the proper plant geometries with the right to direct seedling v/s nursery transplanting randomly or in line sowing pattern to promote its aerial and root growth in order to overcome all of these limitations from the Mid-Himalayan Region of Himachal Pradesh. The farmer typically uses a seed rate of less than 4 kg/ha, however experimental results support using a higher seed rate. It is necessary to sow its seeds in a nursery bed under protected conditions in order to have a 30-35 day-old seedling for transplanting in the main field, either randomly or in line sowing according on the soil conditions, in order to lessen the shy germination impact of its seeds.

The length and quality of the roots, which contain the majority of the therapeutic ingredients such withanolides and alkaloids, may also be improved. This technology may increase the amount of leaves, plant height, and branching.

Material and Method

During the summer of 2021, the experiment was carried out at the Dr. K.S Gill Akal College of Agriculture, Eternal University, Baru Sahib Research Farm, which was located at an elevation of 6233 m above mean sea level at 30.7°N latitude and 77.3°. About 985.8 mm of rain fell on the area each year, primarily from June to September. The direct seeding of ashwagandha was carried out by adopting two different sowing techniques (broadcasting and line sowing) with two different levels of seed rates (4 kgha^{-1} and 5.5 kgha^{-1}), while maintaining the row distance at 25cm apart. This was done on July 25, 2021, simultaneously in the field and nursery bed. The data captured the mean value of the parameters at 120 and 180 DAS (days after planting) from five randomly selected plants designated on each plot for Root-to-shoot ratio.

Result and Discussion

Table 1 shows data on the effect of different cultivars and cultivars on Ashwagandha root biomass. Root biomass (g/m2) was found to be higher with S2 (5.5 kg ha^{-1}) than with S1 (4 kg seed rate per hectare). Root biomass value (g/m2) recorded under S2 (5.0).5 kg ha^{-1}) and S1 (4 kg ha^{-1}) seed rate 398.9, 450.2 g/m2 and 346.4, 375.1 g/m2 at 120 DAS and 180 DAS (cuts) at 15, respectively has been. At 120 DAS and 180 DAS (cut), root biomass under S2 (5.5 kg ha^{-1}) was 2% and 16.7% higher than S1 (4 kg ha^{-1}), respectively. Cultivation differences can also affect root biomass production. The highest root biomass recorded in M3 (random change) was 383.Root biomass at 120 DAS and 180 DAS (cut) was 5 g/m2 and 428.5 g/m2, while the lowest root biomass obtained from M2 (seeded) was 355.1 and 397 at corresponding levels such as growth/m2, 7 g. Root biomass (378.M4 (line) is made in the second row (7 and 420.7 g/m2), which is higher than M1 (post) and M2 (line). Likewise, M1 was better than M1 at two stages of crop growth (120 DAS and 180 DAS), even at the third stage with biomass values of 373.5 and 403.7 g/m2.

Table 1: Effect of seed rates and methods of sowing on Root biomass at 120 DAS and 180 DAS

S. No	Treatments	Root biomass (g m^2)	
		120 DAS	180 DAS
A	**Seed rates**		
	S_1-4 kg ha^{-1}	346.4	375.1
	S_2 – 5.5 kg ha^{-1}	398.9	450.2
	S. Em±	4.79	3.69
	CD $_{0.05}$	14.67	11.30
B	**Methods of Planting**		
	M_1 – Broadcasting	373.5	403.7
	M_2-Line sowing	355.1	397.7
	M_3-Transplanting randomly	383.5	428.5
	M_4-Transplanting in lines	378.7	420.7
	S. Em±	6.77	5.22
	CD $_{0.05}$	20.74	15.98

Conclusion

- The experimental study clearly showed that the root shoot ratio can be maintained with M_3 (transplanting randomly) due to establishment of vigorous plants of ashwagandha obtained from the 30-35 days old seedlings when compared to other planting geometries M_4 (transplanting in lines), M_1 (broadcasting method of sowing) and M_2 (sowing in lines). The higher seed rate (5.5 kg ha^{-1}) also favoured all these parameters due to more plant population obtained in comparison to the application of lower seed rate (4 kg ha^{-1}).
- Highest root-shoot (leaf) ratio (0.39) was noted in M_3 (Transplanting randomly) and was found statistically higher to other methods of planting M_4, M_1, M_2 having root shoot (leaf) ratio of 0.36, 0.35 and 0.32 respectively at harvest. The root-shoot (leaf) ratio remained non significant under the use of both levels of seed rates (4 kg per ha and 5.5 kg ha^{-1}).

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