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Komal Morya
Student of M.Sc. (Ag.) Final Year, Department of Agronomy, IGKV, Raipur, Chhattisgarh, India

Dr. SS Tuteja
Principal Scientist, Department of Agronomy, IGKV, Raipur Raipur, Chhattisgarh, India

Corresponding Author:
Komal Morya
Student of M.Sc. (Ag.) Final Year, Department of Agronomy, IGKV, Raipur, Chhattisgarh, India

Effect of different nutrient management practices on growth and yield of ashwagandha (*Withania somnifera* L.)

Komal Morya and Dr. SS Tuteja

Abstract
The research work entitled "Effect of different nutrient management practices on growth and yield of ashwagandha (*Withania somnifera* L.)" was carried out in *Rabi* season of 2021-22 under the Department of Agronomy, College of Agriculture, IGKV, Raipur, (C.G.) The main objective was to analyze the effect of different nutrient management combinations in treatments on growth and yield of ashwagandha crop. There were total ten treatments, comprises of T_1: 100% RDN (60:40:40 N:P_2O_5:K_2O kg ha^{-1}), T_2: 100% RDN + 5t FYM ha^{-1}, T_3: 100% RDN + 1.0 t vermicompost ha^{-1}, T_4: 100% RDN + Foliar spray (NPK 19:19:19 at 0.5%), T_5:75% RDN + 5t FYM ha^{-1}, T_6 :50% RDN + 5t FYM ha^{-1}, T_7:75% RDN + Foliar spray (NPK 19:19:19 at 0.5%), T_8:50% RDN + Foliar spray (NPK 19:19:19 at 0.5%), T_9: 10 t FYM ha^{-1} and T_{10}: 100% RDN through organic sources (1/3rd FYM + 1/3rd Vermicompost + 1/3rd Neem cake). The experiment revealed that the application of 100% RDN + 5t FYM ha^{-1} significantly increased the plant growth parameters such as plant height, number of branches $plant^{-1}$ and number of leaves $plant^{-1}$. Significantly higher yield attributes such as number berries $plant^{-1}$ (148.3), number of seeds $berry^{-1}$ (44.33), 1000 seed weight (2.39), seed yield ha^{-1} (103.62 kg ha^{-1}), root yield ha^{-1} (522.2 kg ha^{-1}) and straw yield ha^{-1} (852.15 kg ha^{-1}) was also recorded with the application of the 100% RDN + 5t FYM ha^{-1} during the course of investigation.

Keywords: Ashwagandha, vermicompost, foliar spray, neem cake, growth attributes, yield attributes

Introduction
Withania somnifera is generally known as ashwagandha. The species name "*somnifera*" means "sleep inducing" in Latin. The name "ashwagandha" is a combination of the Sanskrit words '*ashva*', meaning horse, and '*gandha*', meaning smell, reflecting that the root has a strong horse-like odor.

Ashwagandha (*Withania somnifera* Dunal.) belong to the family (Solanaceae), known as "Indian ginseng" is a reputed medicinal herb grown for its roots in arid and semi-arid regions of many countries. It is an erect growing, branching shrub with a normal height of 1.50 m. Ashwagandha is a dryland medicinal crop having tremendous marketing potential owing to demand of its roots to the tune of 7000 tones and estimated production of 1500 tones (Kumar *et al.*, 2018) [1].

It is considered to be one of the best rejuvenating agents in Ayurveda. Its roots, seeds and leaves are used in Ayurvedic and Unani medicines. Ashwagandha root drug finds an important place in treatment of rheumatic pain, inflammation of joints, nervous disorders and epilepsy. Dried roots are used as tonic for hiccup, cold, cough, female disorders, as a sedative, in care of senile debility, ulcers, etc. Leaves are applied for carbuncles, inflammation and swellings. Leaf juice is useful in conjunctivitis. Bark decoction is taken for asthma and applied locally to bed sores. Ashwagandha and its extracts are used in preparation of herbal tea, powders, tablets and syrups.

Madhya Pradesh, Gujarat, Haryana, Maharashtra, Punjab, Rajasthan and Uttar Pradesh are the main producing states of this crop in the country. In Madhya Pradesh alone it is cultivated in more than 5000 ha. The estimated production of its roots in India is more than 1500 t, while the annual requirement is about 7000 t necessitating increase in its cultivation for higher production.

Among the several constraints, improper nutrient management is one of the factors responsible for the low productivity (Sarvade *et al*., 2014; Chopra *et al*., 2017) [3, 4]. Chemical fertilizers though played an important role to meet out the nutritional demand of the crop but continuous use of chemical fertilizers is reported to have deleterious effects on soil health.

However, in the use of organic manures along with inorganic fertilizers not only improve physio-chemical and biological properties of soil but also provides all the nutrients in available form to crop, which enhance growth and yield of *W. somnifera*. Thus, there is a need to formulate integrated nutrient management for increasing the production and productivity of *W. somnifera*. Thus, keeping the above point in view and fulfill the increasing demand of roots of this important crop, present investigation was carried out.

Materials and Methods

The present investigation on "Effect of different nutrient management practices on growth and yield of ashwagandha (*Withania somnifera* L.)" was carried out during Rabi 2021-2022 at the Herbal Garden, I.G.K.V., Raipur (C.G.). The topography of the experimental site was uniform. The soil at the experimental site of Herbal Garden, I.G.K.V, Raipur (C.G.) is medium clayey with uniform texture belonging to the order *vertisols* locally known as *kanhar* soil. The meteorological data from sowing to harvesting of crop (15th December, 2021 to 16th May 2022) was observed and recorded at meteorological observatory of the Agrometeorological Department, College of Agriculture, IGKV, Raipur. The average maximum temperature recorded during the growth period was 44 °C and average minimum temperature recorded was 17.8 °C. The average rainfall recorded during the growth period was 11.17 mm. The experimental field was laid out in Randomized block design (RBD) with 10 treatments in 3 replications. The ten treatments were T_1: 100% RDN (60:40:40 $N:P_2O_5:K_2O$ kg ha^{-1}), T_2: 100% RDN + 5t FYM ha^{-1}, T_3: 100% RDN + 1.0 t vermicompost ha^{-1}, T_4: 100% RDN + Foliar spray (NPK 19:19:19 at 0.5%), T_5: 75% RDN + 5t FYM ha^{-1}, T_6 :50% RDN + 5t FYM ha^{-1}, T_7:75% RDN + Foliar spray (NPK 19:19:19 at 0.5%), T_8:50% RDN + Foliar spray (NPK 19:19:19 at 0.5%), T_9: 10 t FYM ha^{-1} and T_{10}: 100% RDN through organic sources ($1/3^{rd}$ FYM + $1/3^{rd}$ Vermicompost + $1/3^{rd}$ Neem cake). Seeds of Jawahar Ashwagandha-134 variety was used in the experiment. It has been released variety from the College of Horticulture, Mandsaur, JNKVV, Jabalpur, Madhya Pradesh. Sowing was done in nursery and was transplanted to the main field after 25 days maintaining a row spacing of 30 cm.

Results and Discussion

Plant height, Number of branches plant^{-1} and Number of leaves plant^{-1}

The variation in plant height, number of branches plant^{-1} and number of leaves plant^{-1} due to different nutrient management combinations were recorded and presented in Table 1. The significant variation among different treatments was observed. The maximum plant height (59.3 cm), number of branches plant^{-1} (10.9) and number of leaves plant^{-1} (151.12) was observed with the application of 100% RDN (60:40:40 $N:P_2O_5:K_2O$ kg ha^{-1} + 5t FYM ha^{-1}), whereas the minimum plant height (41.4 cm), number of branches plant^{-1} (6.22) and number of leaves plant^{-1} (98.1) was observed with the application of 50% RDN + foliar spray (19:19:19 at 0.5%). Application of inorganic fertilizers in combination with FYM and vermicompost helped in better cell division, cell expansion and enlargement, which led to higher plant height of ashwagandha, also it helped in the enhancement of physical and biological properties of soil, which in turn resulted in formation of higher number of branches and leaves in plants. Similar results were obtained by Murarkar *et al.* (1998) [5] and Malviya *et al.* (2017) [6] in ashwagandha.

Number of berries plant^{-1}, number of seeds berry^{-1} and 1000 seed weight

The data in Table 2 represents the number of berries plant^{-1}, number of seeds berry^{-1} and 1000 seed weight at maturity. There was significant variation among different treatments. Maximum number of berries plant^{-1} (148.3) and maximum number of seeds berry^{-1} (44.33) was observed with the application of 100% RDN + 5t FYM ha^{-1}. There was no significant variation on 1000 seed weight due to variation in nutrient management in ashwagandha. The highest value of 1000 seed weight (2.39 g) was also recorded with the application of 100% RDN + 5t FYM ha^{-1}. The minimum value for number of berries plant^{-1} (105.01) number of seeds berry^{-1} (27) and 1000 seed weight (2.29) was observed with the application of 50% RDN + foliar spray (19:19:19 at 0.5%). Slow decomposition and release of nutrients in the soil for crop plants by vermicompost led to lower number of berries in the treatments having vermicompost combination with inorganic nutrients. While better result was obtained with the combination of inorganic and FYM because of rapid release of nutrients by FYM than vermicompost. Similar results were recorded by Atul *et al.* (2018) [9] where integrated use of nutrients gave highest number of berries per plant and seeds per berry.

Seed yield, root yield and straw yield ha^{-1}

The seed yield, root yield and straw yield ha^{-1} showed significant variation due to nutrient management in different treatments. The data related to them are presented in table 3. The maximum value for seed yield (103.62 kg ha^{-1}), root yield (522.2 kg ha^{-1}) and straw yield (852.15 kg ha^{-1}) ha^{-1} was recorded with the application of 100% RDN + 5t FYM ha^{-1}, whereas minimum value for seed yield (58.83 kg ha^{-1}), root yield (305.84 kg ha^{-1}) and straw yield (562.36 kg ha^{-1}) ha^{-1} was recorded with the application of 50% RDN + Foliar spray (NPK 19:19:19 at 0.5%) ha^{-1}. Seed yield is the result of various growth parameters of crop plants and yield attributing characters of crop such as number of berries per plant and number of seeds per berry could be the potential explanation for the highest yield of seeds in treatments with higher dose of inorganic nutrients and organic manure (FYM) in an integrated manner and lowest yield due to lower amount of inorganic nutrients. Similarly better plant growth and higher number of leaves simultaneously increased leaf area for photosynthesis and straw yield. Also, N plays an important role in photosynthesis. Increasing the application of nitrogen synthesizes more amount of photosynthates. All these resulted in translocation of high amount of food to the roots and increased its biomass thus providing higher root yield. Similar results were obtained by Atul *et al.* (2018) [9] and Vijaya *et al.* (2013) [8] while working on ashwagandha.

Table 1: Effect of nutrient management on plant height, number of branches plant^{-1} and number of leaves plant^{-1} of ashwagandha

Treatments	Plant height (cm)	Number of branches plant^{-1}	Number of leaves plant^{-1}
T_1: 100% RDN (60:40:40 N:P_2O_5:K_2O kg ha^{-1})	54.4	8.91	130.67
T_2: 100% RDN + 5t FYM ha^{-1}	59.3	10.90	151.12
T_3:100% RDN + 1.0 t vermicompost ha^{-1}	58.6	10.41	145.40
T_4: 100% RDN + Foliar spray (NPK 19:19:19 at 0.5%)	58.9	8.95	131.20
T_5:75% RDN + 5t FYM ha^{-1}	55.2	10.30	140.33
T_6 :50% RDN + 5t FYM ha^{-1}	48.2	7.00	118.21
T_7 :75% RDN + Foliar spray (NPK 19:19:19 at 0.5%)	50.8	6.81	112.02
T_8 :50% RDN + Foliar spray (NPK 19:19:19 at 0.5%)	41.4	6.22	98.10
T_9: 10 t FYM ha^{-1}	46.8	7.10	115.20
T_{10} - 100% RDN through organic sources (1/3rd FYM + 1/3rd Vermicompost + 1/3rd Neem cake)	47.5	7.30	117.10
SEm±	1.38	0.39	3.87
CD at 5%	4.10	1.15	11.50

Table 2: Effect of nutrient management on number of berries plant^{-1}, number of seeds berry^{-1} and 1000 seed weight of ashwagandha

Treatments	Number of berries plant^{-1}	Number of seeds berry^{-1}	1000 seed weight (g)
T_1: 100% RDN (60:40:40 N:P_2O_5:K_2O kg ha^{-1})	134.00	37.56	2.33
T_2: 100% RDN + 5t FYM ha^{-1}	148.30	44.33	2.39
T_3: 100% RDN + 1.0 t vermicompost ha^{-1}	146.64	42.00	2.37
T_4: 100% RDN + Foliar spray (NPK 19:19:19 at 0.5%)	135.60	37.53	2.34
T_5:75% RDN + 5t FYM ha^{-1}	142.71	41.72	2.37
T_6 :50% RDN + 5t FYM ha^{-1}	120.00	32.30	2.32
T_7 :75% RDN + Foliar spray (NPK 19:19:19 at 0.5%)	113.63	30.05	2.31
T_8 :50% RDN + Foliar spray (NPK 19:19:19 at 0.5%)	105.01	27.00	2.29
T_9: 10 t FYM ha^{-1}	124.30	33.67	2.30
T_{10} - 100% RDN through organic sources (1/3rd FYM + 1/3rd Vermicompost + 1/3rd Neem cake)	125.63	34.03	2.30
SEm±	2.18	1.03	0.34
CD at 5%	6.50	3.07	NS

Table 3: Effect of nutrient management on seed yield, root yield and straw yield of ashwagandha.

Treatments	Seed yield (kg ha^{-1})	Root yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1: 100% RDN (60:40:40 N:P_2O_5:K_2O kg ha^{-1})	75.64	449.71	747.31
T_2: 100% RDN + 5t FYM ha^{-1}	103.62	522.20	852.15
T_3: 100% RDN + 1.0 t vermicompost ha^{-1}	98.10	513.22	818.01
T_4: 100% RDN + Foliar spray (NPK 19:19:19 at 0.5%)	78.55	451.50	760.85
T_5:75% RDN + 5t FYM ha^{-1}	90.21	498.20	774.19
T_6 :50% RDN + 5t FYM ha^{-1}	67.30	390.82	725.80
T_7: 75% RDN + Foliar spray (NPK 19:19:19 at 0.5%)	65.82	360.71	661.29
T_8: 50% RDN + Foliar spray (NPK 19:19:19 at 0.5%)	58.83	305.84	562.36
T_9: 10 t FYM ha^{-1}	67.10	390.23	624.19
T_{10} - 100% RDN through organic sources (1/3rd FYM + 1/3rd Vermicompost + 1/3rd Neem cake)	68.90	394.80	645.69
SEm±	6.29	15.08	30.64
CD at 5%	18.70	44.80	90.96

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