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Impact of bio-stimulants on growth and yield of cowhage (*Mucuna pruriens* L.)

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Abstract
An experiment was conducted at ICAR - Krishi Vigyan Kendra, Hadonahalli, Doddaballapur taluk, Bengaluru Rural district, Karnataka during the years 2020 and 2021 to evaluate the impact of bio-stimulants on growth and yield of cowhage. Experiment consists of soil and foliar application of humic acid, amino acid, sea weed extract, microbial consortia based bio- stimulants. The experiment was conducted by adopting randomized complete block design (RCBD) with 9 treatments in three replication. Maximum plant height (315.3 cm), number of branches (8.18), leaf area (18101 cm^2), leaf area index (5.03), days to 50% flowering (95.23), number of flowers per inflorescence (10.72), days taken for maturity (190.23), pod length (10.23 cm), pod width (2.15 cm), pod weight (6.43 g), number of pods per plant (38.55), seed weight per plant (154 g $plant^{-1}$) and seed yield (43.02 q ha^{-1}) was recorded with RDF+ foliar application of humic acid based bio-stimulant. Lower growth and yield attributes were found in plants supplied only with recommended dose of fertilizers.

Keywords: Cowhage, RDF, bio-stimulants, humic acid, foliar spray

Introduction
Cowhage (*Mucuna pruriens* L.), belongs to the family fabaceae, sub family papilionaceae, which includes approximately 150 species of annual and perennial legumes. In the Indian System of Medicine, it is commonly referred to as "Magic Bean." It is also known as cowhedge, velvet Bean or cowitch in English, kiwanch or konch in Hindi, and kapikacchu or atmagupta in Sanskrit.

It is cultivated in Asia, America, Africa and the Pacific Islands, where its young leaves serve as animal feed and its pods are used as a vegetable by humans. The plant has alternate, lanceolate leaves, long, slender branches and white flowers with a bluish-purple, butterfly-shaped corolla. The long, leathery and hairy pods are four to six inch long and contains four to six seeds. They have thick, luscious and dark brown hair.

Seed is a source of minerals and has several functions like treating Parkinson’s disease, impotence and worms. Apart from this, seeds act as an anabolic, androgenic, analgesic, anti-inflammatory, anti-depressant, anti-spasmodic, anti-venom, anti-lithiatic, anti-bacterial, anti-parasitic, febrifuge, lowering cholesterol, hypoglycaemic, immune modulator, lowering blood pressure and stimulant of uterine (Natarajan *et al*., 2012) [11]. The higher concentration of protein, lipids, minerals, carbohydrates, fibre and amino acids are found in the seeds of mucuna.

Although mucuna species are vulnerable to frost and perform poorly in cold, wet soils, the majority of them show reasonable resistance to a variety of abiotic challenges, including drought, low soil fertility and high soil acidity (Duke, 1981) [4]. The genus does well in warm, moist environments with 1500 m above mean sea level and of regular rainfall. The velvet bean, like the majority of legumes, has the capacity to fix atmospheric nitrogen through a symbiotic partnership with soil microbes.

In recent years, the usage of bio-stimulants in agriculture has developed as a crucial agro-ecological technique. Bio-stimulants are materials, other than fertilizers, that promote plant growth when applied in low quantities. In fact, bio-stimulant appears as a versatile descriptor of any substance beneficial to plants without being nutrients, pesticides or soil improvers. Distinct plant bio-stimulants have different impacts on medicinal plants when used in various quantities and through different mechanisms of action (Rafiee *et al*., 2016) [12].

Material and Methods
The field experiment was conducted during *rabi*, 2020 at ICAR - Krishi Vigyan Kendra, Hadonahalli, Doddaballapur Taluk, Bengaluru Rural Dist, Karnataka which is situated under the agro-climatic zone V: (Eastern dry zone) of Karnataka at $12^0 58'$ North latitude and $77^0 35'$ East longitude with an altitude of 896 m above mean sea level.

The soil of the experimental site was red soil with medium fertility level. The experiment included 9 treatments laid out in randomized complete block design with three replication. Treatments involved soil and foliar application of bio-stimulants *viz.*, T_1-RDF (Control), T_2-RDF+ Soil application of Humic acid based bio-stimulant, T_3- RDF+ Foliar application of Humic acid based bio-stimulant, T_4- RDF+ Soil application of Amino acid based bio-stimulant, T_5- RDF+ Foliar application of Amino acid based bio-stimulant, T_6-RDF+ Soil application of Sea weed extract based bio-stimulant, T_7- RDF+ Foliar application of Sea weed extract based bio-stimulant, T_8 -RDF+ Soil application of Microbial based bio-stimulant, T_9- RDF+ Foliar application of Microbial based bio-stimulant. The cowhage variety Arka Dhanwantari seeds were sown in lines at the rate of 30kg/ha with a depth of 2 cm, maintaining 60 cm row to row and 60 cm plant to plant spacing. The soil was fertilized with 100: 80: 40 kg N:P:K/ ha and 15t/ ha FYM before sowing. The different bio- stimulants *viz.*, Humic acid @ 3 ml/l, Amino acid @ 3 ml/l, Sea weed extract @ 1 ml/l, Arka microbial consortia @10 ml/ l were applied to the crop at 30 and 60 days after sowing, maintaining the quantity of 1500 l/ ha for soil application and 750 l/ha for foliar application.

Results and Discussion

Plant Growth

Plant growth attributes were significantly influenced by the application of different bio-stimulants. Maximum vine length (315.23 cm), number of branches (8.18), leaf area (18101 cm^2) and leaf area index (5.03) was registered with RDF+ Foliar application of humic acid based bio-stimulant at 120 days after sowing. While, plants supplied with only RDF recorded lesser vine length, number of branches, leaf area and leaf area index (Table 1).

Increased plant growth is probably due to the balanced application of nutrients through RDF and bio-stimulants which might have created a microclimate condition for better root growth and proliferation and absorption of more nutrients from soil. This could have led to proper cell division and higher meristematic activity resulting in maximum plant height, number of branches, leaf area and leaf area index. Similar findings were also reported by Jasim and Alghrebawi (2020) [7], Yousif *et al*. (2019) [18] in broad beans, Al-Zyadi and Al-Thahab (2019) [2] and Majid *et al*. (2019) [8] in fenugreek.

The treatment comprising of RDF+ Foliar application of humic acid based bio-stimulant took maximum days to 50% flowering (95.23) and days to maturity (190.23). The same treatment combination produced maximum number of inflorescence per plant (10.72). While, control plants registered lesser days to 50% flowering (72.3) and days to maturity (162.8). Whereas, lesser number of inflorescence per plant (5.54) was noticed in untreated plants (Table 2).

Humic acid have been shown to stimulate plant growth and flowering by acting on the mechanisms involved in physiological respiration. It involves in photosynthesis, protein synthesis, water and nutrient uptake, cation exchange capacity, enzyme activities and antioxidant metabolism. Rapid increase in cell division and cell elongation in the meristematic region were found in plants sprayed with bio-stimulants resulted in improving plant vegetative growth and in turn delays flowering and maturity. These results are in accordance with findings of Nabi and Obaid (2019) [10] in broad beans, Ruban *et al*. (2019) [14] in brinjal and Bahrun *et al*. (2019) [3] in soybean.

Yield

The number of pods per plant significantly varied with bio-stimulant treatments. RDF+ Foliar application of humic acid based bio-stimulant put forth maximum number of pods per plant (38.55) which is *at par* with RDF+ Foliar application of sea weed extract based bio-stimulant and RDF+ Foliar application of amino acid based bio-stimulant. Whereas, minimum number of pods per plant (28.74) was found in control plants (Fig. 1).

Among different soil and foliar nutrition treatments, maximum pod length (10.23 cm) was recorded with RDF + foliar application of humic acid based bio-stimulant which was *on par* with RDF + foliar application of sea weed extract based bio-stimulant (9.65 cm). While, lesser pod length were produced in control plants. RDF + foliar application of humic acid based bio-stimulant resulted in maximum pod width (2.15 cm) which is *at par* with RDF+ foliar application of sea weed extract based bio- stimulant (2.10 cm) and RDF+ foliar application of amino acid based bio- stimulant (1.92 cm). Whereas, plants supplied only with RDF recorded lesser pod width (Table.3).

Maximum pod weight (6.43 g) was found with RDF + foliar application of humic acid based bio-stimulant which is *on par* with RDF + foliar application of sea weed extract based bio-stimulant (6.02 g). While, control plants recorded lesser pod weight. Higher seed yield per plant (154 g $plant^{-1}$) was noticed with RDF +foliar application of humic acid based bio-stimulant, which is at par with RDF + foliar application of seaweed extract based bio stimulant (146.18 g $plant^{-1}$) and RDF + foliar application of amino acid based bio stimulant. While, the significantly seed yield was recorded in untreated plants (Fig. 2).

Significantly maximum seed yield (43. 02 q ha^{-1}) was realised with RDF + foliar application of humic acid based bio-stimulant which was *at par* with RDF + foliar application of sea weed based bio-stimulant (40.60 q ha^{-1}). While, lesser seed yield (24.71 q ha^{-1}) was noticed with control plants (Table 3).

The significant increase in pod length and width was probably due to the role of humic acid, which influences the respiration process, the amount of sugars, amino acids and nitrate accumulation (Unlu *et al*., 2011) [17]. These results are in line with the findings of Abd Elhakem *et al*. (2021) [1], Moosavi (2017) [9] in fenugreek, Refaay *et al*. (2021) [13] in common beans and Sary *et al*. (2020) [15] in soybean.

Increase in yield could also attributed to availability of more nutrients like nitrogen and phosphorous from the bio-stimulants, which is responsible for the production of more number of branches, leaf area and higher photosynthesis that enhances the food accumulation and also the diversion of photosynthates towards sink resulting in better growth and subsequently higher number of flower and increase in the yield (Hegde *et al*., 2016) [5]. Similar findings were reported by Jasim and Al-Amiri (2020) [7], Szparaga *et al*. (2019) [16] in broad bean.

Present investigation revealed that, RDF+ Foliar application of humic acid based bio-stimulant resulted in better plant growth and yield in cowhage.

Table 1: Influence of bio-stimulants on growth attributes in cowhage

Treatments	Vine length (cm)	Number of branches	Leaf area (cm^2)	Leaf area index
	120 DAS			
T_1 - Control	195.53^g	4.53^e	10790^h	3.0^f
T_2- RDF+ Soil application of Humic acid based bio-stimulant	272.13^c	7.36^{abc}	15616^c	4.34^c
T_3 - RDF+ Foliar application of Humic acid based bio-stimulant	315.23^a	8.18^a	18101^a	5.03^a
T_4 - RDF+ Soil application of Amino acid based bio-stimulant	231.24^e	6.50^{cd}	12851^{ef}	3.57^{de}
T_5 - RDF+ Foliar application of Amino acid based bio-stimulant	253.99^{cd}	7.10^{bcd}	14652^d	4.07^c
T_6 - RDF+ Soil application of Sea weed extract based bio-stimulant	239.07^{de}	6.85^{bcd}	13383^e	3.72^d
T_7 - RDF+ Foliar application of Sea weed extract based bio-stimulant	292.13^b	7.58^{ab}	16888^b	4.69^b
T_8 - RDF+ Soil application of Microbial based bio-stimulant	210.27^{fg}	6.32^d	11948^g	3.32^{ef}
T_9 - RDF+ Foliar application of Microbial based bio-stimulant	227.04^{ef}	6.46^{cd}	12411^{fg}	3.45^{de}
S.Em.±	6.64	0.38	200.04	0.10
CD@5%	19.90	1.15	599.71	0.31

Note: DAS – Days after sowing

Table 2: Effect of bio-stimulants on inflorescence characteristics and days to maturity in cowhage

Treatments	Days to 50% flowering	Number of inflorescence plant^{-1}	Days to maturity
T_1 - Control	72.3^e	5.54^g	162.8^d
T_2- RDF+ Soil application of Humic acid based bio-stimulant	86.12^{bc}	8.2^{de}	173.19^c
T_3 - RDF+ Foliar application of Humic acid based bio-stimulant	95.23^a	10.72^a	190.23^a
T_4 - RDF+ Soil application of Amino acid based bio-stimulant	77.84^{de}	7.73^{ef}	168.28^{cd}
T_5 - RDF+ Foliar application of Amino acid based bio-stimulant	90.55^{abc}	9.51^{bc}	175.79^{bc}
T_6 - RDF+ Soil application of Sea weed extract based bio-stimulant	83.45^{cd}	8.07^{de}	170.12^{cd}
T_7 - RDF+ Foliar application of Sea weed extract based bio-stimulant	92.54^{ab}	10.29^{ab}	181.09^b
T_8 - RDF+ Soil application of Microbial based bio-stimulant	75.71^e	6.82^f	164.11^d
T_9 - RDF+ Foliar application of Microbial based bio-stimulant	89.22^{abc}	8.81^{cd}	174.24^{bc}
S.Em.±	2.22	0.34	2.44
CD@5%	6.65	1.02	7.32

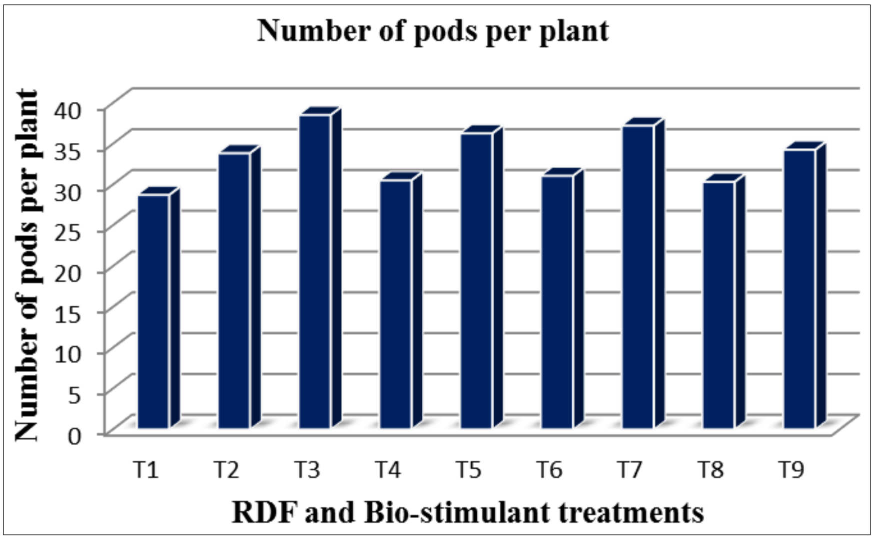

Fig 1: Influence of bio-stimulants on number of pods per plant in cowhage

Table 3: Yield attributes as influenced by bio-stimulants in cowhage

Treatments	Pod length (cm)	Pod width (cm)	Pod weight (g)	Seed yield (q/ha)
T_1 – Control	6.96^{f}	1.57^{c}	4.79^{d}	24.71^{f}
T_2 - RDF+ Soil application of Humic acid based bio-stimulant	8.2^{de}	1.70^{bc}	5.41^{cd}	32.97^{cd}
T_3 - RDF+ Foliar application of Humic acid based bio-stimulant	10.23^{a}	2.15^{a}	6.43^{a}	43.02^{a}
T_4 - RDF+ Soil application of Amino acid based bio-stimulant	7.87^{e}	1.63^{bc}	5.17^{cd}	28.74^{ef}
T_5 - RDF+ Foliar application of Amino acid based bio-stimulant	9.07^{bc}	1.92^{ab}	5.63^{bc}	36.92^{b}
T_6 - RDF+ Soil application of Sea weed extract based bio-stimulant	8.03^{de}	1.65^{bc}	5.32^{cd}	29.42^{de}
T_7 - RDF+ Foliar application of Sea weed extract based bio-stimulant	9.65^{ab}	2.10^{a}	6.02^{ab}	40.60^{a}
T_8 - RDF+ Soil application of Microbial based bio-stimulant	7.82^{ef}	1.60^{bc}	5.09^{cd}	27.25^{ef}
T_9- RDF+ Foliar application of Microbial based bio-stimulant	8.74^{cd}	1.74^{bc}	5.44^{c}	34.37^{bc}
S.Em.±	0.28	0.10	0.16	1.22
CD @ 5%	0.84	0.30	0.48	3.66

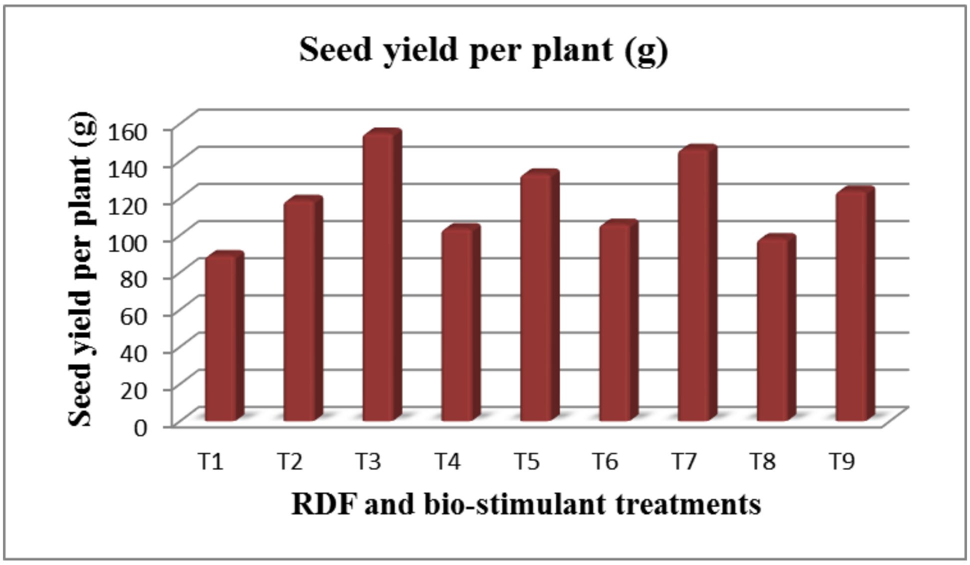

Fig 2: Effect of bio-stimulants on seed yield per plant in cowhage

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