Morphology and Influence of Various Plant Growth Substances on Germination and Early Seedling Growth in *Macrotyloma uniflorum* (Lam.)


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**Abstract**

The paper presents the results of studies on morphological characters, seed germination and the influence of different concentrations of plant growth substances on *Macrotyloma uniflorum* including the comparative growth patterns of the seedlings. This is one of the lesser known beans mainly cultivated in hilly areas and commonly grown up at 1800m above MSL. Seeds pre-soaked for 24h in various concentrations (0.1, 1.0 and 10 ppm) of GA$_3$, IBA and NAA respectively putting a separate control set soaked only in distilled water. The mean value of germination percentage, growth of root, shoot and cotyledonary expansion and biomass of seedlings were computed. The maximum germination percentage (99%) was observed through GA$_3$ 0.1ppm and NAA 1 ppm in comparison to control set (90%). Although highest elongation of shoot was observed under GA$_3$ 10 ppm (11.29 cm) and lowest under GA$_3$ at 1 ppm (10.45 cm) in comparison to control (7.50 cm) but the highest elongation of root was favoured by GA$_3$ at 0.1 ppm (4.46 cm) whereas, the minimum was observed under NAA at 10 ppm (1.28 cm). The maximum Cotyledon expansion was gained in GA$_3$ at 1ppm (5.36 cm) as compared to controlled set (2.94 cm). IBA 0.1 ppm resulted in highest dry weight of shoot (0.0183 g.) as compared to control (0.0172 g.) while dry weight of root was recorded highest under NAA at 10 ppm (0.0076 g). Lower concentrations of all the plant growth substances exhibited supportive response towards germination, growth of seedlings and development of cotyledons. The results of present findings show that applications of these plant growth substances if used at lower concentrations could enhance gerinations and healthy seedling growth leading towards high production of *Macrotyloma uniflorum* to fulfill the demand of farming community. It is thus imperative that more identical studies be conducted on other legume species also generating data base so that the use of growth substances can be extended to produces healthy seedlings required to support large scale seed germination and plantations of those species. [Journal of American Science 2009;5(6):43-50]. (ISSN: 1545-1003).

**Keyword:** *Macrotyloma uniflorum*, Morphology, Plant Growth Substances, Seed Germination, Seedling Growth.

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**Introduction**

Production of high quality seeds is primary source to the success of Indian agriculture. Every farmer is sensitive to need for the rapid uniform seedling emergence and establishment of an even and productive stand. Crop production relies heavily on high quality planting seeds. The latest ISTA rules (ISTA, 2008) contain seed testing protocols of a large number of species cultivated all over the world and it forms the basic reference book for all kinds of seed testing activities and also for the international seed trade. Seeds are fundamental input to agriculture and natural ecosystem. The production of high percentage of viable seeds with capacity to germinate quickly is necessary for the propagation. Seed quality is very essential for optimum stand establishment and maximum yield potential. As a result, it is necessary
to have different seed testing parameters that permit rapid, objective and accurate evaluation of seed quality (S.C. Joshi et al 2009).

Horse gram (*Macrotyloma uniflorum* Lam) is a popular pulse, locally known as Gaheth belongs to the family Fabaceae that still remain an under exploited legume crop. It is usually grown up to the area at 1800msl. Horse gram seeds are rich in protein and consumed in majority by poorest section of the society. The fodder being rich in protein; it is widely used as a feed to animals and horses (B. G. Prakash et al. 2008). Dehusking, germination, cooking, and roasting have been shown to produce beneficial effects on nutritional quality of the legumes. Seeds and fruits of different species vary greatly in appearance, shape, size and ornamentation and structure of the embryo in relation to storage tissues. In some legumes seed coat colour is quite heterogeneous within a sample and such seeds often comprise a germplasm accession in a gene bank. Correlation of different seed coat colours with seed quality parameters may provide a non-destructive tool (especially useful in a gene bank) for sorting good quality seeds.

Germination represents a critical event in plant’s life cycle and its timing largely predetermined the chances of survival of a seedling up to maturity (Thompson, 1973). Temperature is an important physical parameter of an environment, which determines the success or failure of a species in a particular locality, which in turns depends mostly on the germinability of the seed. It is well known that the different population of the same species varies in their temperature and light requirements for germination. Germination requirements of a particular species are a result of the interaction of its genetic makeup with the environment and dormancy pattern of seeds of various plant species, which enable them to survive during adverse conditions (Wittington, 1973; Nikolaeva, 1977). The germination of seed is affected by hormonal secretion and enzymatic activity with in the seeds. Gibberellins (GA₃) and Auxin- IBA (Indolebutyric acid), IAA (Indole acetic acid) control many behavioral functions in plants which act as chemical messengers influencing many patterns of plant development. These stimulate cell division and cell elongation and control enzyme secretions. Seed germination and seedling growth can be influenced by various concentrations of growth regulators i.e. GAs and IAA (Chauhan et al. 2009).

The present investigation is carried out to investigate the response of different concentrations of the Plant Growth Substances on seed germination, root, shoot and hypocotyls elongation and biomass production of seedlings. Some morphological features of seed of Horse gram have also been observed with germination processes.

**Material and Methods**

The seeds of *Macrotyloma Uniflorum* were collected from Jakh village of District Tehri of Uttarakhad, India. The observation recorded on various morphological features of the seed such as shape, size, colour, ornamentation, length and width, fresh and dry weight of seed, floral characters along with length and width of pod, pods per plant and seed per pod etc. After thorough mixing, the whole lot was sampled and dried in open air for ten days and stored at room temperature till the experimentation. The moisture content of seeds was determined by air oven method. Subsequently, the sample contained in glass and dried thermostatically at room temperature and weighed, then placed in hot air oven at 80°C for 48hrs to find out the average dry weight and calculated using the following formula (Anonymous, 1976).

\[
\text{Moisture content (\%) = \frac{\text{Fresh Weight} - \text{Dry weight}}{\text{Fresh weight}} \times 100}
\]

Seeds were pre-soaked for 24h under the different concentrations of Plant Growth Substances (0.1, 1.0 and 10 ppm) of GA₃, IBA and NAA. A control set was soaked only in distilled water. The seeds were placed on a wet filter paper in petridish and kept in Seed Germinator. The mean value of germination percentage, growth of root, shoot and cotyledonary expansion and biomass of seedlings were computed on each alternate day till the final day of experimentation (Table 1).
Table 1. The effects of various concentrations of different plant growth substances on seed germination and seedling growth of *Macrotyloma uniflorum*.

<table>
<thead>
<tr>
<th>Plant Growth Substances</th>
<th>Concentrations used</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA₃</td>
<td>0.1ppm 1ppm 10ppm</td>
</tr>
<tr>
<td>IBA</td>
<td>0.1ppm 1ppm 10ppm</td>
</tr>
<tr>
<td>NAA</td>
<td>0.1ppm 1ppm 10ppm</td>
</tr>
<tr>
<td>Control</td>
<td>Only distilled water</td>
</tr>
</tbody>
</table>

Results and Discussion

*Macrotyloma Uniflorum* is an erect, sub-erect or trailing, densely hairy annual herb. The tap root produces a branched root system with smooth, rounded nodules. Seed is small somewhat gray to brown with pale fawn in colour sometimes with faint mottles or with small scattered black spots or with both. Seed size ranges 6-8 mm long and 3-4mm broad smooth of which 100 seed weight is recorded 3.65gm. The flowers are short and only 6-12 mm long cream - yellow with purple spot in auxiliary racemes with 2 appendages at base. The pods are 4-6 cm long and about 6 mm broad with 18-23 pods per plant bearing 6-7seeds per pod. Flowering and fruiting takes place between August to October (Table-2).

Correlation of different seed coat colours with seed quality parameters may provide a non-destructive tool (especially useful in a gene bank) for sorting good quality seeds. Relationship between seed coat colour and quality parameters in horse gram (*Macrotyloma uniflorum*) was studied by Singh et al. (2009) in seeds separated in to pale brown, medium brown and blackish brown coloured fractions in 20 accessions of horse gram. Seed quality was assessed in terms of germination, seedling vigour and seed storability. The light coloured fractions consistently showed highest germination percentage and seedling vigor followed by medium and dark coloured fractions in all the accessions. Percentage seed moisture content and electrical conductivity were observed to be highest in the dark coloured seeds. Light coloured seeds showed better storability after three years of ambient storage whereas the medium and dark coloured seeds were poor in germination and showed significant decline. Colour of seeds can be used as a visual indicator of seed quality and storability in horse gram.

Table 2. The Morphological Features of *Macrotyloma uniflorum* Seeds

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Parameters studied</th>
<th>Range of Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Shape of seed</td>
<td>Seeds are small and somewhat round</td>
</tr>
<tr>
<td>2.</td>
<td>Colour</td>
<td>Gray to brown with pale fawn in colour. Sometimes with faint mottles or with small scattered black spots or with both.</td>
</tr>
<tr>
<td>3.</td>
<td>Ornamentation</td>
<td>Smooth and ovoid</td>
</tr>
<tr>
<td>4.</td>
<td>Length of seed</td>
<td>6-8 mm</td>
</tr>
<tr>
<td>5.</td>
<td>Width of seed</td>
<td>3-4 mm broad</td>
</tr>
<tr>
<td>6.</td>
<td>Seed fresh weight (100)</td>
<td>3.65 gm</td>
</tr>
<tr>
<td></td>
<td>Seed dried weight</td>
<td>1.095 gm</td>
</tr>
<tr>
<td>7.</td>
<td>Flowers</td>
<td>Short only 6-12 mm long. The flower is cream - yellow with purple spot in auxiliary racemes with 2 appendages at base.</td>
</tr>
<tr>
<td>8.</td>
<td>Pod</td>
<td>Shorty stipitate, slightly curved and tomentose.</td>
</tr>
<tr>
<td>9.</td>
<td>Length and width of pod</td>
<td>4-6 cm long and about 6 mm broad with a point about 6 mm long.</td>
</tr>
<tr>
<td>10.</td>
<td>Pods per plant</td>
<td>18-23 pods</td>
</tr>
<tr>
<td>11.</td>
<td>Seed per pod</td>
<td>Usually bear 6 or 7 seed per pod.</td>
</tr>
<tr>
<td>12.</td>
<td>The sowing time of the seed</td>
<td>Last week of June to first week of July.</td>
</tr>
<tr>
<td></td>
<td>Flowering and fruiting period</td>
<td>The plant attains flowers and fruits between Aug to Oct.</td>
</tr>
</tbody>
</table>
The crop is harvested, when the seeds turn to shining brown-grey color, generally during mid Oct to Nov.

The observations of the experiment showed that GA$_3$ 0.1ppm and NAA 1ppm resulted in equal 99 percent germination which was followed by IBA10ppm (96%) while control set showed lowest germination (90%). GA$_3$ 1, GA$_3$10, IBA 0.1, and IBA-1ppm resulted in equal percent germination (98). Within the concentrations, the NAA 10ppm responded only 96 percent germination which is less than the control. (Table 3 and Fig. 1).

In case of the seedling growth, GA$_3$ at 10ppm attained maximum (11.29cm) shoot length which was followed by GA$_3$ at 1ppm (10.45cm) and IBA at 0.1ppm (9.23cm). Minimum shoot length was observed under NAA 10ppm (7.02cm) that was slightly lower than the control set (7.50cm). As far as root growth is concerned, it was observed highest under GA$_3$-at 0.1ppm (4.46) followed by NAA at 1ppm (4.07). The lowest performance with regards to the root length was recorded under NAA at 10ppm (7.02cm) that was slightly higher than the control set (7.50cm).The cotyledon expansion was observed highest under the influence of GA$_3$ 1ppm (5.36 cm) that was followed by GA$_3$10ppm(3.79, Fig-4). The control set exhibited (2.94 cm) a little higher than NAA-10 ppm (2.27).

The highest cotyledons development has enhanced under the GA$_3$ at 1ppm (5.36 ±0.5cm) concentration that was followed by GA$_3$ at 100ppm (5.36 ±0.5cm) and GA3 0.1 ppm(3.65 ±0.3). The lowest growth was recoded under the influence of NAA 10ppm (2.27 ±0.2) which is less than the control set (2.94 ±0.2, Fig-2). Dry weight of root biomass in case of controlled set was observed to be 0.0047±0.004g. The maximum dry weight of root was found in NAA at 10 PPM (0.0076 ±0.006g) and minimum dry weight of root was observed under GA$_3$ at 10 PPM (0.0021±0.002). The maximum fresh weight of shoot (0.0183 ±0.5) was observed under IBA at 0.1 ppm whereas, the dry weight of shoot under the control set has recorded higher (0.0172±0.2) than some of other concentrations (Table-4 and Fig.3).

### Table 3: Effect of Various Concentrations of Plant Growth Substances on the Seed Germination and Seedling Development of Macrotyloma uniflorum.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Germination %</th>
<th>Shoot Length (cm)</th>
<th>Root Length (cm)</th>
<th>Cotyledon Expansion (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA$_3$ 0.1 ppm</td>
<td>99</td>
<td>9.53 ±0.7</td>
<td>4.46 ±0.3</td>
<td>3.65 ±0.3</td>
</tr>
<tr>
<td>GA$_3$ 1 ppm</td>
<td>98</td>
<td>10.45 ±0.5</td>
<td>3.57 ±0.2</td>
<td>5.36 ±0.5</td>
</tr>
<tr>
<td>GA$_3$ 10ppm</td>
<td>98</td>
<td>11.29 ±0.8</td>
<td>3.69 ±0.5</td>
<td>3.79 ±0.2</td>
</tr>
<tr>
<td>IBA-0.1 ppm</td>
<td>98</td>
<td>9.23 ±0.7</td>
<td>3.86 ±0.3</td>
<td>3.05 ±0.3</td>
</tr>
<tr>
<td>IBA-1 ppm</td>
<td>98</td>
<td>8.34 ±0.7</td>
<td>3.95 ±0.3</td>
<td>2.91 ±0.2</td>
</tr>
<tr>
<td>IBA-10 ppm</td>
<td>96</td>
<td>9.50 ±0.7</td>
<td>3.55 ±0.3</td>
<td>2.94 ±0.2</td>
</tr>
<tr>
<td>NAA-0.1 ppm</td>
<td>97</td>
<td>8.54 ±0.8</td>
<td>1.93 ±0.5</td>
<td>3.12 ±0.5</td>
</tr>
<tr>
<td>NAA-1 ppm</td>
<td>99</td>
<td>8.84 ±0.8</td>
<td>4.07 ±0.5</td>
<td>2.8 ±0.2</td>
</tr>
<tr>
<td>NAA-10 ppm</td>
<td>96</td>
<td>7.02 ±0.8</td>
<td>1.28 ±0.5</td>
<td>2.27 ±0.2</td>
</tr>
<tr>
<td>CONTROL</td>
<td>95</td>
<td>7.50 ±0.8</td>
<td>3.68 ±0.5</td>
<td>2.94 ±0.2</td>
</tr>
</tbody>
</table>

### Table 4: Effect of Various Concentrations of Plant Growth Substances on the Shoot and Root Dry Weight of Macrotyloma uniflorum.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Shoot Dry Weight(gm)</th>
<th>Root Dry Weight(gm)</th>
<th>Shoot: root ratio</th>
<th>Epicotyls length(cm)</th>
<th>No. of Roots</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA$_3$ 0.1 ppm</td>
<td>0.0143 ±0.5</td>
<td>0.0053 ±0.005</td>
<td>1: 13</td>
<td>2.92</td>
<td>7</td>
</tr>
<tr>
<td>GA$_3$ 1 ppm</td>
<td>0.0174 ±0.2</td>
<td>0.0029 ±0.002</td>
<td>1:0.8</td>
<td>2.62</td>
<td>9</td>
</tr>
<tr>
<td>GA$_3$ 10ppm</td>
<td>0.0162 ±0.2</td>
<td>0.0021 ±0.002</td>
<td>1:0.2</td>
<td>3.52</td>
<td>9</td>
</tr>
<tr>
<td>IBA-0.1 ppm</td>
<td>0.0183 ±0.5</td>
<td>0.0043 ±0.003</td>
<td>1: 4.1</td>
<td>3.46</td>
<td>8</td>
</tr>
<tr>
<td>IBA-1 ppm</td>
<td>0.0152 ±0.5</td>
<td>0.0036 ±0.003</td>
<td>1:3.6</td>
<td>3.44</td>
<td>8</td>
</tr>
<tr>
<td>IBA-10 ppm</td>
<td>0.0137 ±0.2</td>
<td>0.0053 ±0.005</td>
<td>1:3.5</td>
<td>1.87</td>
<td>8</td>
</tr>
<tr>
<td>NAA -0.1 ppm</td>
<td>0.0140±0.2</td>
<td>0.0045 ±0.004</td>
<td>1:0.6</td>
<td>2.45</td>
<td>7</td>
</tr>
<tr>
<td>NAA-1 ppm</td>
<td>0.0143 ±0.2</td>
<td>0.0055 ±0.005</td>
<td>1:40</td>
<td>2.58</td>
<td>7</td>
</tr>
</tbody>
</table>
Heavy seeds generally have shown superior germination, survivorship, and seedling mass as also have been mentioned by Aaron M. Ellison (2001). The findings of Douglass H (1985) have summarized that seed size and germination requirements can be determined to be useful characters for resolving systematic and phylogenetic problems. Archna and Shivana (1985) have studied the requirements for seed germination and seedling formation of a hemi-root parasite *Sopubia delphinifolia*.

| NAA- 10 ppm | 0.0175 ±0.5 | 0.0076 ±0.006 | 1:1.8 | 0.29 | 6 |
| Control     | 0.0172 ±0.2 | 0.0047 ±0.004 | 1: 6.7 | 2.85 | 7 |

Light was found to be essential for germination; none of the growth substances could replace the light requirement. Seed must attain certain minimum specific moisture content, before they
germinate (Negbi et al., 1966). GA₃ at 0.1 ppm affected germination the most, leading 4% higher than the control. The more effective concentration has been proved to be GA₃ at 10 ppm with regards to shoot growth (11.29 ±0.8) at the cost of only 1% less germination. The same concentration resulted in almost equal growth of root (3.69 ±0.5) in comparison to control set. Response of lower and middle level of concentration such as GA₃ at 0.1 ppm and NAA at 1 ppm has shown remarkable germination and seedling growth in Macrotyloma. GA₃ resulted in maximum shoot growth (11.29±0.8) in comparison to Control (7.50±0.8). These concentrations have shown good response on cotyledons development (5.36±0.5). As far as dry weight of shoot and root is concerned, GA₃ at 10 ppm resulted less responsive in comparison to IBA 0.1 (0.0183±0.5) and GA₃ 1 ppm (0.0174±0.2).

The effect of seed-soaking for 24 hours with different Plant Growth Substances has been examined by M. Grzesik. (2006) on the growth of seedlings of Lathyrus odoratus, Zinnia elegans, Matthiola incana and Antirrhinum majus. GA₃ improved the germination of the treated seeds. The seedlings of Zinnia, Matthiola
and *Antirrhinum*treated with NAA, GA$_3$ and GA$_4$,
where higher, better branched and of better quality
than the non-treated plants. Singh and Dara (1971)
have shown the results on Influence of pre-soaking of
seeds with gibberellins and Auxin on growth and yield
attributes of wheat under high salinity, sodium
adsorption ratio and boron levels. Similar efforts have
been made through another experiment by M. Farooq
et al. (2006) to investigate the possibility of rice seed
invigoration by pre-sowing ethanol seed treatment.
They revealed that employing ethanol treatments at
lower concentrations can invigorate fine rice seeds.
High temperature both delayed and inhibited the
germinations of barley and radish seeds (Cavusoglu K
& Kabar K 2007). Irfan Afzal et al., (2005) have
shown the effects of seed soaking with plant growth
regulators (IAA, GA$_3$, and Kinetin) on wheat
emergence and seedling growth under normal and
saline conditions and found their usefulness in
increasing relative salt-tolerance. Among the 14 pre-
sowing treatments, KNO$_3$ (150 min) and NaHClO$_3$ (30
min) significantly stimulated seed germination of
*Angelica glauca* and reduced mean germination time
under both laboratory and nursery trials, as well as
developed seedling vigour under nursery conditions
(Jitendra S. Butola and Hemant K. Badola 2004). A
similar experiment was carried out by Gao Huan
Zhang et al. (2002) in which Walnuts cv. Jianshi were
soaked in water (control), IBA at 80 mg/kg, IAA at
100 mg/kg, NAA at 80 mg/kg, ABT root-growing
powder at 1 g/kg, or 6-BA at 5 mg/kg. In this
experiment, different concentrations of GA$_3$, IBA and
NAA, the maximum germination percentage (100%)
was recorded in seed treated with IBA 0.1 ppm, which
shows that the lower concentrations of growth
hormone shows better performance than higher which
was similar to the results of James Chukwuma

The results of the present findings are parallel to the
findings of Parameswari and Srimathi (2008) to
evaluate the influence of plant growth substances on
seed germination and seedling quality characteristics
of tamarind seeds. They revealed that the concentration
of 100 and 200 ppm GA3 were found to
enhance both the seed germination and seedling vigour
parameters, such as root length, shoot length,
hypocotyl length, dry matter production and vigour
index values. Seed fortification with GA3 100 ppm
performed well even under nursery conditions
recording a higher leaf number and stem circumference.

IBA proved good in seedlings biomass production.
However, lower concentrations of all the plant growth
substances exhibited supportive response towards

## References

[1] Aaron M. Ellison. Interspecific and intraspecific
variation in seed size and germination requirements of
*Sarracenia* (*Sarraceniaceae*). *American Journal of

and Seedling Growth in *Sopubia delphinifolia*- a
Hemi-root Parasite: Germination Requirements.

Identification of Suitable Horse gram Varieties for
Northern Dry Zone of Karnataka. *Karnataka J. Agric.
Sci.* 2008; 21(3): 343-345.

[4] Cavusoglu K, Kabar K. Comparative effects of
some plant growth regulators on the germination of
barley and radish seeds under high temperature stress.

[5] Chauhan JS, YK Tomar, N Indrakumar Singh,
Seema Ali, Debarati. Effect of Growth Hormones on
Seed Germination and Seedling Growth of Black
Gram and Horse Gram. *Marsland Press. Journal of

Propagule size, dispersal ability, and seedling
Volume 67, Number 3.

Effect of plant growth regulators on seed germination

http://www.americanscience.org/journals
and seedling growth of walnut. Journal of Hubei Agricultural College. 2001; Jingzhou 434025, Hubei, China


