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# Impact of varietal and growth regulator treatments on morpho-physiological characters and quality of mungbean (*Vignaradiata* (L) Wilczek)

**Mahipat Singh Yadav and Sanjay Kumar Singh**

**Abstract**
A field experiment was conducted during summer season 2012 and 2013 at the research farm R.B.S. college Agra, U.P., to find out the effect of different levels of growth regulator on germination percent, germination energy, seed vigour and other characters of Pant mung-5, K-851,SML-668 and Pusa-9072 varieties of mungbean. The significant higher increment was observed in varieties Pant mung-5, P-9072, SML-668 and K-851 under 2,4-D treatments dose $10^{-3}$ in germination percent and plumule length and radicle length in both the years. The maximum germination energy was recorded in varieties Pant mung-5 and K-851 under GA treatment dose $10^{-1}$. The vigour index, number of seed pod$^{-1}$ and 100 seed weight by all varieties gave superior results in both the years. All experimental varieties of mungbean under BA treatment at $10^{-1}$ dose reported highest plant height.

**Keywords:** growth regulator, germination percent and seed vigour.

## 1. Introduction
India is the largest pulses producing country in the world. Pulses are mainly grown in rainfed area. Mungbean (*Vigna radiata* L.) is considered as one of the most important pulse crop in India. It is important legume crop characterized by a relative high content of protein (22%) and short summer season crop. It is one of important pulse crop cultivated in India ranking third having about 70% of the world area and 45% of production. In India area occupied by mungbean is about 23.63 million ha. with total production of 14.56 million tones but average productivity (625 kg/ha) is quite low. The various application of optimum quantity of growth regulators play an important role in high germination and vigour percent in mungbean (Aldesuquy HS. *et al.* 2007) [2] and (Algan N *et al.*2011) [3]. The remarkable research work has not been conducted under arid, semi-arid and rainfed conditions to find out the proper doses of growth regulator application for getting high germination percent, vigour index and productivity in mungbean. Keeping in view the above facts the present study was under taken to find out the effect of application of growth regulator on germination, vigour, productivity and other characters in different varieties of mungbean *viz*.- Pant mung-5, K-851,SML-668 and Pusa-9072 under Agra region.

## 2. Materials and Methods
A field experiment was conducted during summer season 2012 and 2013 at the research farm R.B.S. college Agra, U.P., to find out the effect of four levels viz, control, $10^{-1}$, $10^{-2}$, $10^{-3}$of growth regulators on germination percent, germination energy, seed vigour and other characters of four varieties viz, Pant mung-5, K-851,SML-668 and Pusa-9072 of mungbean. Agra is situated at 27° 11'0" N and 78°1'0" E longitude at an altitude of 171m above mean sea level and has a subtropical climate with dry hot summers and cold winters. The mean maximum temperature during the hottest month (June) ranges between 41-48 °C, while mean minimum temperature in the coldest months (December-January) ranges between 2-8 °C of the average annual rainfall of 695 mm, about 88% is received between June and October and the rest during winters. The experimental design was factorial randomized block with three replications. Urea was the source of nitrogen and the source of sulphur was gypsum while triple super-phosphate was used as source of phosphorus but in case of Potash in soil was rich. The physiological parameters viz, Relative growth rate (RGR), Absolute crop growth rate (ACGR), Net assimilation rate (NAR) and Harvest index (HI) were calculated applying the

formulae giving by (Waston DJ. 1952) [11]. Observations were recorded time to time on germination percentage, germination energy, vigour index, radicle length, plumules length, plant height, number of seeds pod$^{-1}$ and 100 seed weight. The data collected in the experiment for different characters were subjected to statistical test for significance and analysis of variance. Critical difference (CD) values at 5% probability level were computed for making comparisons between treatments. Association between yield and its contributing characters were determined by multiple correlations method and the dependence of yield on its important contributing morphological characters were also determined by the multiple regression method suggested by (Cochran WG and Cox GM 1967) [5].

## 3. Result and Discussion

The results obtained in this study are presented and discussed as under.

### 3.1 Germination percent

The results presented in table-1 showed that priming with growth regulator viz, TIBA and 2,4-D significantly increased the germination percentage at initial stage in all the varieties as compared to other growth regulators. At lower concentrations of TIBA and 2,4-D the germination percentage was maximum. The maximum germination percentage (67.3) was recorded at in $10^{-3}$ doses of 2,4-D and the minimum germination percentage (35.3) was recorded in $10^{-1}$ BA. These findings are in concordance with the reports of (Medhi AK *et al.* 2005) [8] among all the four varieties of mung bean increase in seed germination with all the growth regulators over control. In present investigation all the four varieties and in both the years that 2,4-D at lower doses of $10^{-3}$ affected germination percentage, the maximum like TIBA at the some concentration and therefore it can be concluded 2,4-D and TIBA at lower doses act as promoters of germination percentage and act as growth promoters than retardants. Similar findings were reported by (Medhi AK *et, al.*2011) [7] who reported that the growth regulators. TIBA at lower doses act as promoters germination percentage as compared to other growth regulators.

### 3.2 Germination energy

It is revealed from table-1 that the maximum germination energy was observed by the varieties of mungbean (SML-668, K-851, P-9072 and Pant mung-5) treated with GA at doses $10^{-3}$,$10^{-1}$,$10^{-2}$ and $10^{-1}$ in 2012 and $10^{-1}$,$10^{-1}$, $10^{-3}$ and $10^{-2}$ in 2013 respectively. The similar trend was observed by all varieties treated with BA doses $10^{-3}$, $10^{-1}$, $10^{-3}$ and $10^{-1}$ in 2012 and $10^{-2}$, $10^{-1}$, $10^{-1}$, $10^{-1}$ in 2013 respectably. The application of IAA with dose $10^{-2}$ as seed treatment showed the better response by P-9072 and Pant mung-5 in 2012 and 2013. All varieties showed dose $10^{-1}$ of TIBA and 2,4-D is superior irrespective of germination energy among all doses in 2012 and 2013. The results are in agreement with those obtained by (Devi RG *et al.* 2012) [6].

### 3.3 Plumule length

In table-1 it was observed that there was a significant increment was observed in plumule length over control in TIBA and 2,4-D at dose $10^{-3}$ in all varieties in both the years. In case of variety, SML-668 and K-851 at par in all doses of GA and IAA over control. The 2,4-D treatment was found superior than TIBA in variety Pant mung-5 and P-9072 in both experimental years. The results are in conformity with the findings of (Al-Delaimy AOA *2013*) [1]. This behavior of the growth regulators was consistent for all varieties in both the years. It is therefore, concluded that the plumule length was increasing maximum by 2,4-D and TIBA as compared to GA, IAA and BA in that order and all the varieties responded more or less the same way. Similar findings were reported by (Algan N *et al. 2011*) [3].

### 3.4 Radicle length

The results presented in table-1 the lowest dose $10^{-3}$ of GA was significantly better in increasing the radicle length (18.33, 18.00cm) in variety SML-668 and (19.70, 19.72cm) in variety K-851 as compared to IAA in both the years. In variety SML-668 and K-851, BA showed the least increase in radicle length at all the doses, as compared to all other growth regulators. In Pant mung -5 and P-9072 the dose of $10^{-1}$ of both GA and IAA significantly increased the radicle length. However, the dose of $10^{-3}$ was as good as control whereas the $10^{-1}$ dose of GA and IAA were significantly better than control. It can be concluded that the treatment with 2,4-D and TIBA at the highest dose was as good as control whereas at dose of $10^{-3}$ was significantly better in increasing the radicle length. A significant increment was recorded in case of 2,4-D and TIBA dose $10^{-3}$ the radicle length of varieties SML-668 and K-851 over control in both years. The radicles were stouter, stronger and thicker than the control and both GA and IAA affected treatments. This aspect had a great bearing on the health of the plants that were in generally healthier when treated with 2.4-D and TIBA in case of K-851.These results are in conformity with the findings of (Aldesuquy HS *et al. 2007*) [2] who also reported increase in radicle length with increase in doses of treatments.

### 3.5 Vigour index

It was observed in table- 2 that each growth regulator induced significant changes in vigour index and that each dose also made significant impact dose at all intervals induced the highest vigour index as compared to any other growth regulator at any dose, followed by 2,4-D, it was TIBA again at $10^{-3}$ that induced the highest vigour index between various doses of TIBA and 2,4-D, each dose induced a significant impact over the other dose $10^{-1}$ being the lowest. The impact of 2,4-D ($10^{-3}$) and TIBA ($10^{-3}$) was significantly better than the control where all other growth regulator and the corresponding doses were inferior to the control except GA ($10^{-3}$) in 2012 in variety K-851. In case of varieties Pant mung-5 and P-9072, the response to the doses was reversed in case of both GA and IAA because the dose of $10^{-1}$ increased the vigour index. Where in varieties K-851 and SML-668 the response was exactly opposite that is the vigour index in case of BA, TIBA and 2,4-D, increase with the decreasing doses. Similar results were reported by (Ali B *et al.* 2008) [4] who found that the plants would be vigorous and healthy which are obtained after the pre sowing seed treatment with 2,4-D and TIBA at lower doses.

**Table 1:** Effect of growth regulators priming on seed germination, germination energy and some other traits in mungbean in years (2012 and 2013).

| Variety | Growth Regulators | Doses | Germination % | | Germination energy | | Plumule length (cm) | | Radicle length (cm) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| Pant mung-5 | Control | | 65.3 | 55.3 | 400.0 | 817.0 | 17.3 | 18.6 | 15.9 | 15.6 |
| | GA | $10^1$ | 55.3 | 53.3 | 1000 | 917.0 | 16.0 | 16.1 | 17.2 | 16.4 |
| | GA | $10^2$ | 53.3 | 58.6 | 933.5 | 900.0 | 15.6 | 15.8 | 15.9 | 16.2 |
| | GA | $10^3$ | 52.6 | 60.6 | 900.0 | 867.0 | 15.3 | 15.4 | 15.6 | 15.8 |
| | BA | $10^1$ | 45.3 | 50.6 | 883.5 | 883.0 | 13.6 | 13.8 | 15.6 | 15.8 |
| | BA | $10^2$ | 46.0 | 52.6 | 816.5 | 883.0 | 13.8 | 14.6 | 15.2 | 15.6 |
| | BA | $10^3$ | 47.3 | 54.6 | 800.0 | 817.0 | 13.9 | 14.1 | 14.9 | 15.2 |
| | IAA | $10^1$ | 51.3 | 52.6 | 833.0 | 867.0 | 14.8 | 14.9 | 17.1 | 16.2 |
| | IAA | $10^2$ | 50.0 | 57.3 | 850.0 | 817.0 | 14.5 | 14.6 | 15.8 | 16.1 |
| | IAA | $10^3$ | 49.3 | 59.3 | 833.5 | 816.0 | 14.1 | 14.7 | 15.5 | 15.7 |
| | TIBA | $10^1$ | 54.6 | 55.3 | 933.5 | 850.0 | 16.9 | 17.0 | 12.3 | 13.7 |
| | TIBA | $10^2$ | 58.0 | 58.6 | 866.5 | 850.0 | 16.9 | 17.0 | 12.4 | 13.5 |
| | TIBA | $10^3$ | 63.3 | 60.6 | 867.0 | 833.5 | 17.4 | 15.5 | 12.6 | 13.1 |
| | 2,4-D | $10^1$ | 63.6 | 56.6 | 916.5 | 853.5 | 17.6 | 17.7 | 12.2 | 13.4 |
| | 2,4-D | $10^2$ | 56.3 | 59.3 | 850.0 | 817.0 | 17.9 | 18.1 | 12.3 | 13.6 |
| | 2,4-D | $10^3$ | 67.3 | 61.3 | 816.5 | 767.0 | 18.4 | 18.6 | 12.4 | 13.8 |
| | CD at 5% | | 0.47 | 2.48 | 28.5 | 19.2 | 0.27 | 0.29 | 1.52 | 0.21 |
| SML-668 | Control | | 60.6 | 50.6 | 983.5 | 1083.5 | 17.6 | 17.7 | 18.2 | 17.7 |
| | GA | $10^1$ | 55.3 | 45.3 | 1050.0 | 1150.0 | 17.5 | 17.6 | 18.2 | 17.6 |
| | GA | $10^2$ | 58.0 | 43.3 | 1050.0 | 1117.0 | 17.6 | 17.7 | 18.2 | 17.7 |
| | GA | $10^3$ | 60.0 | 41.3 | 1083.0 | 116.5 | 17.7 | 17.7 | 18.3 | 17.7 |
| | BA | $10^1$ | 50.0 | 38.0 | 933.5 | 1083.0 | 17.2 | 17.2 | 17.5 | 17.2 |
| | BA | $10^2$ | 53.3 | 39.3 | 916.5 | 1067.0 | 17.3 | 18.4 | 17.6 | 18.4 |
| | BA | $10^3$ | 55.3 | 41.3 | 983.0 | 1066.5 | 17.4 | 17.4 | 17.7 | 17.4 |
| | IAA | $10^1$ | 57.3 | 44.6 | 1033.5 | 1133.0 | 17.3 | 17.3 | 18.0 | 17.3 |
| | IAA | $10^2$ | 60.6 | 42.0 | 1033.5 | 1133.0 | 17.4 | 17.5 | 18.1 | 17.5 |
| | IAA | $10^3$ | 62.0 | 40.6 | 1017.0 | 1100.0 | 17.5 | 17.6 | 18.2 | 17.6 |
| | TIBA | $10^1$ | 58.0 | 45.3 | 1000.0 | 1200.0 | 17.5 | 17.6 | 18.3 | 17.6 |
| | TIBA | $10^2$ | 61.3 | 46.0 | 1000.0 | 1167.0 | 17.7 | 17.2 | 18.3 | 17.2 |
| | TIBA | $10^3$ | 97.3 | 48.6 | 900.0 | 1200.0 | 17.8 | 17.8 | 18.3 | 17.8 |
| | 2,4-D | $10^1$ | 96.6 | 50.6 | 983.5 | 1116.5 | 17.9 | 18.0 | 18.3 | 18.0 |
| | 2,4-D | $10^2$ | 97.3 | 51.3 | 1000.0 | 1150.0 | 18.1 | 18.2 | 18.4 | 18.2 |
| | 2,4-D | $10^3$ | 65.3 | 53.3 | 1016.5 | 1133.0 | 18.3 | 18.3 | 18.5 | 18.3 |
| | CD at 5% | | 1.21 | 2.49 | 28.5 | 36.1 | 0.77 | 0.41 | 0.71 | 0.41 |
| P-9072 | Control | | 62.6 | 53.3 | 616.0 | 700.0 | 16.8 | 17.2 | 15.8 | 15.1 |
| | GA | $10^1$ | 52.6 | 50.6 | 783.0 | 867.0 | 17.1 | 17.1 | 17.0 | 16.0 |
| | GA | $10^2$ | 50.6 | 55.3 | 800.0 | 867.0 | 16.7 | 18.8 | 15.0 | 15.9 |
| | GA | $10^3$ | 48.6 | 58.0 | 783.5 | 900.0 | 16.3 | 16.4 | 15.7 | 15.4 |
| | BA | $10^1$ | 40.6 | 45.3 | 700.0 | 750.0 | 13.3 | 13.3 | 15.0 | 15.2 |
| | BA | $10^2$ | 42.6 | 47.3 | 733.5 | 750.0 | 13.7 | 13.8 | 15.0 | 15.1 |
| | BA | $10^3$ | 44.6 | 49.3 | 750.0 | 750.0 | 14.2 | 14.5 | 15.2 | 15.2 |
| | IAA | $10^1$ | 49.3 | 48.0 | 716.5 | 833.0 | 14.6 | 14.6 | 17.1 | 16.2 |
| | IAA | $10^2$ | 47.3 | 53.3 | 733.5 | 900.0 | 14.6 | 14.3 | 17.2 | 16.2 |
| | IAA | $10^3$ | 46.0 | 57.3 | 700.0 | 866.5 | 13.5 | 13.6 | 17.0 | 16.1 |
| | TIBA | $10^1$ | 55.3 | 55.3 | 767.0 | 833.0 | 17.2 | 17.4 | 13.0 | 14.1 |
| | TIBA | $10^2$ | 56.6 | 57.3 | 733.5 | 850.0 | 17.4 | 18.0 | 13.4 | 14.4 |
| | TIBA | $10^3$ | 58.6 | 59.3 | 666.5 | 817.0 | 18.2 | 18.3 | 135 | 14.6 |
| | 2,4-D | $10^1$ | 60.6 | 54.0 | 683.0 | 800.0 | 18.2 | 18.0 | 13.4 | 14.6 |
| | 2,4-D | $10^2$ | 63.3 | 58.0 | 666.5 | 750.0 | 18.5 | 18.8 | 13.4 | 14.4 |
| | 2,4-D | $10^3$ | 65.3 | 60.0 | 683.0 | 750.0 | 19.5 | 18.8 | 13.7 | 14.9 |
| | CD at 5% | | 0.28 | 2.78 | 22.1 | 17.1 | 0.51 | 0.75 | 0.62 | 0.56 |
| K-851 | Control | | 62.6 | 46.6 | 1050.0 | 1033.0 | 19.5 | 14.7 | 20.2 | 20.3 |
| | GA | $10^1$ | 58.6 | 40.6 | 1083.0 | 1050.0 | 19.2 | 19.3 | 19.5 | 19.6 |
| | GA | $10^2$ | 60.0 | 38.6 | 1033.0 | 933.5 | 19.4 | 19.5 | 19.6 | 19.6 |
| | GA | $10^3$ | 62.6 | 37.3 | 950.0 | 900.0 | 19.5 | 19.6 | 19.7 | 19.7 |
| | BA | $10^1$ | 55.3 | 35.3 | 966.5 | 1000.0 | 18.8 | 18.8 | 18.9 | 18.9 |
| | BA | $10^2$ | 60.6 | 36.6 | 950.0 | 967.0 | 18.9 | 19.0 | 19.2 | 19.2 |
| | BA | $10^3$ | 60.6 | 38.0 | 950.0 | 967.0 | 19.1 | 19.1 | 19.3 | 19.3 |
| | IAA | $10^1$ | 62.6 | 39.3 | 1133.5 | 1067.0 | 19.1 | 19.1 | 19.4 | 19.4 |
| | IAA | $10^2$ | 63.3 | 37.3 | 1050.0 | 1000.0 | 19.3 | 19.4 | 19.4 | 19.5 |
| | IAA | $10^3$ | 62.3 | 36.6 | 1000.0 | 950.0 | 19.5 | 19.5 | 19.5 | 19.5 |
| | TIBA | $10^1$ | 63.3 | 40.6 | 933.0 | 1016.5 | 19.5 | 19.8 | 19.9 | 19.9 |
| | TIBA | $10^2$ | 62.0 | 42.6 | 916.5 | 950.0 | 19.7 | 19.9 | 20.0 | 20.0 |
| | TIBA | $10^3$ | 63.3 | 44.6 | 900.0 | 917.0 | 19.9 | 20.0 | 2.1 | 20.1 |
| | 2,4-D | $10^1$ | 64.6 | 45.3 | 1016.5 | 1000.0 | 19.7 | 19.9 | 20.2 | 20.5 |
| | 2,4-D | $10^2$ | 64.6 | 47.3 | 950.0 | 950.0 | 19.9 | 20.1 | 21.6 | 21.7 |
| | 2,4-D | $10^3$ | 66.6 | 49.3 | 933.5 | 916.5 | 20.1 | 20.3 | 21.8 | 21.9 |
| | CD at 5% | | 2.41 | 2.02 | 2.41 | 34.7 | 0.62 | 0.38 | 0.72 | 0.11 |

**Table 2:** Effect of growth regulators priming on plant height, number of seeds per pod and some other traits in mungbean in years (2012 and 2013).

| Variety | Growth Regulators | Doses | Vigour index | | Plant height (cm) | | No. of seeds per pod | | 100 seed weight (g) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| Pant mung-5 | Control | | 1516.5 | 1904.2 | 62.6 | 61.6 | 12.0 | 13.0 | 4.2 | 4.5 |
| | GA | $10^1$ | 1481.8 | 1897.4 | 67.0 | 71.0 | 12.3 | 13.3 | 4.9 | 4.4 |
| | GA | $10^2$ | 1425.1 | 1873.9 | 64.6 | 66.7 | 12.0 | 13.3 | 4.8 | 4.3 |
| | GA | $10^3$ | 1371.7 | 1840.0 | 63.6 | 64.7 | 12.0 | 13.3 | 4.7 | 4.2 |
| | BA | $10^1$ | 975.4 | 1709.8 | 70.3 | 76.3 | 12.6 | 13.7 | 4.3 | 4.9 |
| | BA | $10^2$ | 1037.4 | 1735.4 | 68.8 | 72.8 | 12.3 | 13.3 | 4.2 | 4.7 |
| | BA | $10^3$ | 1098.2 | 1791.1 | 66.6 | 69.7 | 12.0 | 13.0 | 4.0 | 4.0 |
| | IAA | $10^1$ | 1173.6 | 190.0 | 66.8 | 68.2 | 12.6 | 13.7 | 4.7 | 4.6 |
| | IAA | $10^2$ | 1116.3 | 1888.4 | 65.3 | 67.4 | 12.3 | 13.3 | 4.5 | 4.5 |
| | IAA | $10^3$ | 1046.4 | 1824.8 | 63.6 | 63.4 | 11.6 | 12.7 | 4.4 | 4.4 |
| | TIBA | $10^1$ | 1470.4 | 1904.8 | 54.5 | 55.8 | 11.6 | 12.7 | 5.0 | 5.0 |
| | TIBA | $10^2$ | 1519.7 | 1928.3 | 60.4 | 57.1 | 12.0 | 13.0 | 5.2 | 5.2 |
| | TIBA | $10^3$ | 1640.7 | 1951.6 | 61.4 | 58.4 | 12.3 | 13.3 | 5.6 | 5.4 |
| | 2,4-D | $10^1$ | 1650.0 | 1931.2 | 58.9 | 53.9 | 11.6 | 12.7 | 5.0 | 4.8 |
| | 2,4-D | $10^2$ | 1702.0 | 1961.4 | 61.7 | 54.7 | 12.0 | 13.0 | 5.2 | 5.2 |
| | 2,4-D | $10^3$ | 1848.7 | 1994.3 | 62.6 | 60.6 | 12.3 | 13.4 | 5.4 | 5.7 |
| | CD at 5% | | 28.5 | 38.4 | 2.77 | 2.33 | 0.94 | 0.94 | 0.06 | 0.37 |
| SML-668 | Control | | 1706.0 | 1557.0 | 32.6 | 34.7 | 10.2 | 11.3 | 5.2 | 5.4 |
| | GA | $10^1$ | 1671.3 | 1397.4 | 44.8 | 51.8 | 10.3 | 11.4 | 5.6 | 5.8 |
| | GA | $10^2$ | 1681.8 | 1335.5 | 42.8 | 50.8 | 10.0 | 11.1 | 5.2 | 5.2 |
| | GA | $10^3$ | 1702.0 | 1295.3 | 39.3 | 42.3 | 9.9 | 11.0 | 4.9 | 4.8 |
| | BA | $10^1$ | 1467.8 | 1029.4 | 41.0 | 48.0 | 9.7 | 10.8 | 4.2 | 4.7 |
| | BA | $10^2$ | 1491.2 | 1051.0 | 38.4 | 41.4 | 9.6 | 10.7 | 4.0 | 4.3 |
| | BA | $10^3$ | 1519.7 | 1125.2 | 30.2 | 31.2 | 9.5 | 10.6 | 3.8 | 4.0 |
| | IAA | $10^1$ | 1568.4 | 1272.8 | 48.6 | 53.6 | 10.4 | 11.5 | 5.8 | 5.9 |
| | IAA | $10^2$ | 1649.9 | 1208.4 | 40.4 | 44.4 | 10.0 | 11.1 | 5.0 | 5.0 |
| | IAA | $10^3$ | 1673.2 | 1150.9 | 36.1 | 40.1 | 9.8 | 10.9 | 4.8 | 4.7 |
| | TIBA | $10^1$ | 1673.2 | 1442.2 | 28.1 | 30.1 | 10.0 | 11.3 | 4.9 | 4.9 |
| | TIBA | $10^2$ | 1703.0 | 1453.4 | 27.1 | 28.2 | 10.3 | 11.4 | 5.3 | 5.4 |
| | TIBA | $10^3$ | 1732.6 | 1477.3 | 34.5 | 36.6 | 10.8 | 11.9 | 5.8 | 5.7 |
| | 2,4-D | $10^1$ | 1732.0 | 1588.5 | 25.1 | 26.2 | 10.3 | 11.4 | 5.0 | 5.0 |
| | 2,4-D | $10^2$ | 1766.7 | 1634.9 | 35.1 | 38.2 | 10.7 | 11.8 | 5.2 | 5.5 |
| | 2,4-D | $10^3$ | 1793.4 | 1729.6 | 31.9 | 33.9 | 10.9 | 12.0 | 5.4 | 5.8 |
| | CD at 5% | | 33.9 | 37.8 | 2.72 | 2.02 | 0.91 | 0.91 | 0.06 | 0.24 |
| P-9072 | Control | | 1559.3 | 1859.1 | 58.3 | 58.3 | 12.3 | 13.4 | 4.5 | 4.4 |
| | GA | $10^1$ | 1495.2 | 1876.8 | 60.7 | 62.7 | 13.0 | 14.0 | 4.4 | 4.5 |
| | GA | $10^2$ | 1433.7 | 1880.0 | 60.0 | 61.1 | 12.6 | 13.7 | 4.3 | 4.4 |
| | GA | $10^3$ | 1394.3 | 1809.5 | 59.1 | 60.1 | 12.3 | 13.4 | 4.1 | 4.3 |
| | BA | $10^1$ | 941.9 | 1579.2 | 65.1 | 68.1 | 12.6 | 13.7 | 4.9 | 5.0 |
| | BA | $10^2$ | 1002.7 | 1617.1 | 63.7 | 67.7 | 11.6 | 12.7 | 4.7 | 4.8 |
| | BA | $10^3$ | 1084.8 | 1672.5 | 61.5 | 63.5 | 11.3 | 12.4 | 4.2 | 4.6 |
| | IAA | $10^1$ | 1242.8 | 1898.1 | 62.1 | 65.2 | 13.0 | 14.0 | 4.5 | 4.5 |
| | IAA | $10^2$ | 1197.6 | 1844.8 | 61.0 | 59.0 | 12.3 | 13.4 | 4.3 | 4.4 |
| | IAA | $10^3$ | 1099.4 | 1782.7 | 57.6 | 56.7 | 11.6 | 12.7 | 4.2 | 4.3 |
| | TIBA | $10^1$ | 1542.6 | 1811.5 | 52.5 | 52.5 | 12.0 | 13.0 | 5.0 | 5.0 |
| | TIBA | $10^2$ | 1631.8 | 1851.8 | 54.5 | 53.5 | 12.3 | 13.4 | 5.2 | 5.7 |
| | TIBA | $10^3$ | 1671.2 | 1897.2 | 56.1 | 54.1 | 12.6 | 13.7 | 5.4 | 5.9 |
| | 2,4-D | $10^1$ | 1674.3 | 1869.9 | 45.7 | 48.7 | 12.0 | 13.0 | 4.6 | 4.9 |
| | 2,4-D | $10^2$ | 1754.7 | 1915.2 | 48.6 | 50.6 | 12.6 | 13.7 | 5.2 | 5.2 |
| | 2,4-D | $10^3$ | 1799.0 | 1956.5 | 49.3 | 51.3 | 13.0 | 14.0 | 5.3 | 5.8 |
| | CD at 5% | | 34.7 | 37.3 | 2.89 | 2.33 | 0.92 | 0.92 | 0.05 | 0.24 |
| K-851 | Control | | 1741.8 | 1624.5 | 45.4 | 51.4 | 11.2 | 12.3 | 4.3 | 5.0 |
| | GA | $10^1$ | 1700.8 | 1399.5 | 63.2 | 67.3 | 12.7 | 13.2 | 5.3 | 5.3 |
| | GA | $10^2$ | 1721.2 | 1320.9 | 60.2 | 64.3 | 11.8 | 12.9 | 5.0 | 5.1 |
| | GA | $10^3$ | 1752.1 | 12.66.9 | 54.1 | 56.2 | 11.4 | 12.4 | 4.7 | 5.0 |
| | BA | $10^1$ | 1582.0 | 1089.4 | 58.3 | 60.4 | 11.4 | 12.5 | 4.8 | 5.0 |
| | BA | $10^2$ | 1619.7 | 1114.7 | 61.5 | 64.5 | 11.2 | 12.3 | 4.4 | 4.6 |
| | BA | $10^3$ | 1637.1 | 1141.3 | 49.1 | 54.2 | 11.3 | 12.2 | 4.1 | 4.1 |
| | IAA | $10^1$ | 1682.7 | 1265.6 | 42.5 | 49.6 | 12.0 | 13.1 | 5.4 | 5.4 |
| | IAA | $10^2$ | 1689.4 | 1210.9 | 40.6 | 43.7 | 11.2 | 12.3 | 4.9 | 5.3 |
| | IAA | $10^3$ | 1706.8 | 1157.4 | 39.7 | 43.7 | 11.0 | 12.0 | 4.2 | 5.1 |
| | TIBA | $10^1$ | 1737.6 | 1507.2 | 37.1 | 37.1 | 11.8 | 12.8 | 4.4 | 4.9 |
| | TIBA | $10^2$ | 1766.7 | 1518.7 | 38.2 | 40.3 | 12.6 | 13.7 | 4.8 | 5.4 |
| | TIBA | $10^3$ | 1786.5 | 1636.2 | 36.4 | 34.4 | 12.8 | 13.8 | 5.2 | 5.7 |
| | 2,4-D | $10^1$ | 1791.4 | 1597.5 | 37.0 | 36.0 | 11.9 | 12.9 | 4.6 | 5.0 |
| | 2,4-D | $10^2$ | 1818.9 | 1694.1 | 38.0 | 39.1 | 12.7 | 13.8 | 4.9 | 5.4 |
| | 2,4-D | $10^3$ | 1822.8 | 1767.3 | 38.4 | 42.5 | 12.9 | 13.9 | 5.1 | 5.6 |
| | CD at 5% | | 26.4 | 28.3 | 4.86 | 4.79 | 0.87 | 0.86 | 0.04 | 0.24 |

### 3.6 Plant height

The data given in table-2 revealed that varieties P-9072 and Pant mung-5, plant height was increased maximum and significantly by BA at $10^{-1}$ dose. However the difference between GA, IAA and BA at $10^{-1}$ dose in increasing the plant height was significantly indicating thereby that the effect of all the doses was not similar. Some was the case for the other doses also. In fact 2,4-D and TIBA in variety Pant mung-5 also significantly decreased the plant height as compared to control or other growth regulator in both the years. The response of varieties Pant mung-5 and P-9072 was different than the varieties K-851 and SML-668 as there was significantly increase or decrease in both the years. In both the varieties SML-668 and K-851 at doses (control, $10^{-1}$, $10^{-2}$, $10^{-3}$) and with all the growth regulators. GA and IAA at all doses significantly increased the plant height whereas TIBA and 2,4-D decreased the plant height significantly. Maximum decrease was induced by the $10^{-1}$ dose of both height minimum as compared to the other dose of the same growth regulators. BA at $10^{-1}$ dose increased the plant height significantly as compared to control and the other doses. These results confirm the findings of (Devi RG *et al.* 2012) [6].

### 3.7 Number of seeds pod$^{-1}$

The results concerning number of seeds pod$^{-1}$ in four varieties of mungbean and all growth regulators, presented in table -2 mungbean varieties of K-851 and SML-668, TIBA and 2,4-D induced a significant increase in number of seeds pod$^{-1}$ at dose ($10^{-3}$) whereas GA and IAA gave the same result at higher dose ($10^{-3}$). However the increase affected by TIBA and 2,4-D was significantly better than GA and IAA. The highest increase (13.9g) was found in 2013 at $10^{-3}$ in case of 2,4-D in general, the role of BA was similar to the higher dose of both TIBA and 2,4-D and the lower concentrations of both GA and IAA. In case of varieties Pant mung-5 and P-9072 the number of seeds pod$^{-1}$ were better as compared to K-851 and SML-668. Each growth regulator, their doses and the interactions between the growth regulator and dose showed their significant impact on the number on seeds pod$^{-1}$, meaning thereby, that Pant mung-5 and P-9072 responded better than the K-851 and SML-668 in all the tested varieties, dose at $10^{-1}$ of GA and IAA and dose at $10^{-3}$ of TIBA and 2,4-D induced more number of seeds as compared to other doses. These results are in full agreement with those observations by (Srimathi, P. *et al. 2006*) [9].

### 3.8 100 seed weight

The data given in table-2 revealed that the varieties K-851 and SML-668, there was significant impact of the growth regulators GA and IAA at dose of $10^{-1}$, and TIBA and 2,4-D at $10^{-3}$ for inducing better 100 seed weight as compared to control. BA at all the doses of $10^{-3}$ had lower 100 seed weight as compared to control. Maximum 100 seed weight was noticed at all the doses of 2,4-D. The response of P-9072 was considerable better than the variety K-851 as in general the 100 seed weight was better. Even the response of BA at $10^{-1}$ and $10^{-2}$ doses was significantly better than the control in Pant mung-5 and P-9072 whereas such response was not observed in the varieties K-851 and SML-668. However, the maximum increase in 100 seed weight was induced by 2,4-D and TIBA. These results are in conformity with the findings of (*Subramanian, A. 1985*) [10] it therefore appears that 2,4-D and TIBA will ultimately result into better yields as they induced better number of seeds pod$^{-1}$ and the number of pods plant$^{-1}$.

## 4. Conclusion

The findings of present study indicate the role of proper varieties and growth regulators for getting higher germination percentage and vigour index in variety pant mung-5 followed by K-851, P-9072 and SML-668 gave better results in order to 2,4-D dose $10^{-3}$ gave higher germination percentage and vigour index as compared to other growth regulators for achieving better plumule length, radicle length, 100 seed weight, number of seeds pod$^{-1}$ and better quality in Agra region.

## 5. References


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