EFFECT OF EXOGENOUS APPLICATION OF BRASSINOSTEROIDE AND SALICYLIC ACID ON GROWTH AND YIELD PARAMETERS OF GROUNDNUT (ARACHIS HYPOGEA L.)

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KEYWORDS

Growth regulators
Brassinosteroides
Salicylic acid
Growth and Groundnut yield
ABSTRACT

To study the impact of Brassinosteroids and Salicylic acid on some morphological criteria and yield of Groundnut, to find out their effective concentrations along with the proper stage of spraying in improving growth and yield parameters in groundnut plants, present investigation was undertaken with Brassinosteroides (BS) at 10 and 15ppm concentrations and Salicylic acid (SA) at 300 and 500ppm concentrations sprayed at just prior to flowering i.e. 20 days after sowing (vegetative stage), and second spraying at reproductive stage (pegging) i.e. 40 days after sowing in another block. The differences in biological yield and partitioning to pod are highly significant due to application of BS @10ppm and SA @300ppm. The major components of biological yield viz. number of branches per plant, pod to peg ratio, total number of immature pods, 100 kernel weight were enhanced significantly by BS and SA at lower concentrations. In conclusion BS @10ppm and SA @300ppm enhanced significantly the pod yield in groundnut via important physiological and yield attributing characters. The study suggest that still lower concentrations of BS and SA should be tried in order to further enhance pod yield in groundnut and derive more economic benefit.

INTRODUCTION

Ground nut (Arachese hypogeal L.), is an important crop worldwide, distributed across the vast area in tropical, subtropical and temperate zones. It is a valuable source of edible oil and protein for human beings and of fodder for livestock. Groundnut accounts for approximately 50% of oilseed production in India and like china, half of the groundnut produced are used for human consumption. Productivity of any crop depends on various physiological and biochemical events at different stages of crop growth. The invention of Brassinisteroid and salicylic acid as plant growth regulators creates an outstanding achievement over traditional plant growth regulators like IAA, GA3, Kinetin, ethylene and ABA which have contributed a promise for yield improvement in various field crops. Brassinoloides is an important steroidal component obtained from pollen grains of Brassica napus L. and Salicylic acid is a phenolic compound obtained from bark of willow tree (Salix sp.). Brassinosteroids are a new addition to the group to PGRs and have emerged as the sixth group of phytoharmones with significant growth promoting activity (Clouse and Sasse, 1998, Rao et al., 2002) and they influence varied physiological processes like growth, germination of seeds, senescence. Recent work on Brassinosteroid biosynthetic mutants in Arabidopsis thaliana (Li et al., 1996) and Pisum sativum (Nomura et al., 1997) has revealed that brassinosteroides are essential for plant growth and development. The ability of exogenously applied brassinosteroides to improve crop yields of ground nut (Vardhini and Rao et al., 1998) has been reported. Salicylic Acid commonly called as “Aspirin” in acetylated form is increasingly being considered as a new PGR. It belongs to a group of chemicals known as phenolic. It has been reported as an allelopathic chemical (Einhellig, 1986). Functionally, it induces flower production as well as improves yield performance (Raskin, 1992). SA increased the number of flowers, pods of lant and yield of soybean (Guiterez- Coronado et al., 1998), enhanced wheat growth (Shakirova et al., 2003) and maize growth (Shehata et al., 2001). On contrary SA at relatively high doses inhibited plant growth of the tomato (Kord and Hathout, 1992) and wheat plants (Singh and Usha, 2003; Iqbal and Ashraf, 2006). Thus SA and BS could be expected to influence the growth and yield of groundnut.

Hence, the present investigation was undertaken in groundnut crop to study the impact of Brassinosteroides and Salicylic acid on some morphological criteria and yield of Groundnut, to find out their effective concentrations along with the proper stage of spraying in improving growth and yield parameters in groundnut plants.

MATERIALS AND METHODS

The field experiment was conducted at main Oilseed Research Farm, Junagadh Agriculture University, Junagadh in Kharif season, 2008 under rainfed condition. The experiment was laid out in a Randomized block Design with four replications, the crop was sown in first week of July. The crop was fertilized with 12.5:25:00
N:P:K kg ha⁻¹, the full dose of Nitrogen and phosphorous was applied as the basal dose at the time of sowing. Growth regulators Brassinosteroids (BS) at 10 and 15 ppm concentrations and Salicylic acid (SA) at 300 and 500ppm concentrations were sprayed at just prior to flowering i.e. 20 days after sowing (vegetative stage) and second spraying done at reproductive stage (peging) i.e., 40 days after sowing in another block, water spray served as the control. For the preparation of 10 and 15ppm Brassinosteroids (1%) solution 50 mL and 75 mL was mixed with tap water and made 5L volume of solution respectively for 300 and 50ppm Salicylic Acid solution 1.5 and 2.5g salicylic acid was diluted in acetone and made 5 it volume of solution. The observations on growth parameters were recorded on number of nodules, number of branches per plant, Time Taken for 40% flowering, root, stem leaf partitioning, Fertility index, Pod to peg ratio. The observations on yield parameters i.e. 100 kernel weight, shelling outturn, oil percent, pod yield, biological yield and harvest index were taken after harvest.

Details of treatments

RESULTS AND DISCUSSION

Number of nodules
Treatments at vegetative stage: The number of nodules increased as growth advanced. The spray of growth regulators at vegetative stage resulted in both positive and negative effects on number of nodules in all growth intervals. Treatment BS10 and 15ppm increased number of nodules per plant at all growth intervals. Overall it was observed that BS10 and 15ppm achieved significantly higher values of nodules per plant than those in SA treatments in all growth stages.

Treatment at reproductive stage: The number of nodules increased as growth advanced. Highest values of nodules per plant was obtained at 90 DAS in BS @ 10ppm (115.65), followed by BS @ 15 ppm (113.63) at same growth period. BS @ 1ppm achieved significantly higher values of nodules per plant than those by SA treatments. The results are supported by findings of Vardhini and Rao, (1999) and Takahashi et al., (1994) who reported that treatments of 24-epibrassinosteroid or 28 – homobrassinosteroid increased the nodulation in ground nut. On the other hand Sato et al., (2002) reported negative effect of salicylic acid on nodulation in soybean, Garg et al., (1989) in pigeon pea.

Number of branches
Treatments at vegetative stage: Highest number of branches per plant were observed in BS @ 10ppm (9.15), followed by SA @ 300pm (8.95), BS @ 15pm (8.90) and SA @ 500ppm (8.18). Lower concentrations were better than higher concentrations in increasing number of branches. Thus, present study revealed that the foliar application of growth regulators was effective in maximizing number of branches.

Treatment at reproductive stage: Highest number of branches per plant was observed in BS @ 10ppm (9.18) followed by SA @ 300ppm (8.90), BS 2 15 ppm (8.88), SA @ 500ppm (8.43) and control (7.30) respectively. The lower concentration of BS 10 ppm and SA @ 300 ppm were more effective than their higher concentrations. These results are in agreement with that of Nanda et al., (1977), who reported increased number of branches in Italian millets by exogenous application of SA. Takahashi et al., (1994) observed that the treatment epibrassinolide increased number of reproductive branches in green gram. Singh et al. (2001) reported number of branches was increased by salicylic acid treatment in green gram. The significant increase in number of branches in growth regulators treated plants might have been translated in increased seed yield because; number of branches appeared to be dominating component for higher number of fruiting nodes with more pod and also influenced canopy growth by increasing leaf area.

Time Taken for 40% Flowering

Treatments at vegetative stage: The treatment Sa 300%ppm was significantly superior over control as it produced 40% flower in 43 days followed by SA @ 500ppm, BS @ 10ppm and BS @ 15ppm which produced 40% flowers in 44, 46 and 47 days respectively.

Treatment at reproductive stage: Application of the growth regulators at reproductive stage was not effective to early flower production, as there was no any significant difference between control and other growth regulators. Among the growth regulators, SA at vegetative stage was more effective to produce flowers earlier than growth regulators and control. The lower concentration of SA was superior to the higher concentrations. Among the growth regulators SA at vegetative stage was more effective to produce flower earlier than other growth regulators and control. These results are strongly supported by the findings of Singh et al., 1998, where they noticed that SA @ 100ppm increased flower production per plant and decreased the number of days to flower initiation in pigeon pea. Zhao et al., (1995), Singh et al. (1980), Zode and Durge, (1988) also observed enhancement of flowering in SA treated plants.

Partitioning of dry matter (%)

Root
Treatments at vegetative stage: Numerically BS @ 10pm partitioned maximum (2.55 percent) dry matter to root and SA @ 500ppm partitioned minimum (1.65 percent) dry matter.

Treatments at reproductive stage: The treatment BS @ 10 ppm was most effective for partitioning of dry matter to roots (2.18 percent), followed by BS 2 15 ppm (2.06 per cent). The treatments of SA @ 300 and 500 ppm were poor in partitioning of dry matter to roots (1.63 and 1.74 per cent) as compared to control (1.86 per cent). It was observed that the partitioning of dry matter to roots was significant with the treatments at reproductive stage. BS (10 and 15ppm) was more effective.
than the SA (300 and 50ppm)

Stem

**Treatments at vegetative stage:** BS@15ppm partitioned 19.60 per cent dry matter to stem, followed by SA@300, BS@10, SA@50ppm had control partitioned 17.38, 16.92, 15.88 and 15.68 per cent dry matter respectively.

**Treatments at reproductive stage:** The values of partitioning obtained in various treatments were as follows: control (water spray) 16.88 per cent, BS@15ppm 15.38 per cent, SA@300ppm 15.18 per cent, SA@2500ppm 14.69 per cent and BS@10ppm 14.59 per cent.

Leaf

**Treatments at vegetative stage:** Growth regulators treatments at vegetative stage numerically increased partition of dry matter to leaf over control (water spray). Treatment BS@10ppm more effectively partitioned dry matter to leaves (11.55) per cent, followed by BS@15ppm, SA@300ppm, SA@500ppm and control (10.32, 9.98, 9.27 and 6.73 per cent) respectively.

**Treatments at reproductive stage:** Partitioning of dry matter to leaves increased by application of growth regulators significantly over control (water spray). Growth regulators spray at vegetative stage showed no significant improvement over control, while significant differences were obtained when growth regulators sprayed at reproductive stage.

Pod

**Treatments at vegetative stage:** Treatments of growth regulators were superior in partitioning dry matter to pod than control (water spray). Treatment BS@10ppm resulted in the highest (62.69) partitioning of dry matter to pods. Treatment BS@15ppm, SA@500ppm and control partitioned 59.04, 58.44 and 55.69 per cent dry matter to pods, respectively. Malik et al., (1995) have demonstrated the shift in source sink assimilates partitioning following foliar applications with triacontanol, brassinosteroids and NAA.

**Treatments at reproductive stage:** Growth regulators were significantly superior over control (water spray) in portioning dry matter to pods when applied at reproductive stage also. Treatment BS@1ppm was the best and it partitioned 64.58 per cent dry matter to pods. The lower concentrations were more effective over control. The enhanced partitioning of dry matter to pods signified that the sink activity was promoted at that period which diverted the flow of food material from other parts to the pod for growth and development of pods and kernels. Those were the main parts of potential yield.

Fruiting efficiency

**Table 1: Effect of Brassinosteroid and Salicylic acid concentrations at vegetative stage**

<table>
<thead>
<tr>
<th>Observations</th>
<th>Brassinosteroid</th>
<th>Salicylic acid</th>
<th>Control</th>
<th>Mean (S.E)</th>
<th>CD at 5%</th>
<th>CV%</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of branches per plant</td>
<td>9.18</td>
<td>8.90</td>
<td>8.95</td>
<td>8.18</td>
<td>7.25</td>
<td>8.49</td>
</tr>
<tr>
<td>40 % flowering in Ground nut</td>
<td>46.00</td>
<td>47.00</td>
<td>43.00</td>
<td>44.00</td>
<td>48.00</td>
<td>45.60</td>
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<tr>
<td>Partitioning of dry matter %</td>
<td>2.55</td>
<td>2.05</td>
<td>1.80</td>
<td>1.65</td>
<td>2.06</td>
<td>2.02</td>
</tr>
<tr>
<td>Stem</td>
<td>16.92</td>
<td>19.60</td>
<td>17.38</td>
<td>15.88</td>
<td>15.68</td>
<td>17.09</td>
</tr>
<tr>
<td>Leaf</td>
<td>11.55</td>
<td>1.32</td>
<td>9.98</td>
<td>9.27</td>
<td>6.73</td>
<td>9.57</td>
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<tr>
<td>Pod</td>
<td>62.69</td>
<td>59.04</td>
<td>6.41</td>
<td>58.44</td>
<td>55.69</td>
<td>59.20</td>
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<tr>
<td>Fertility index</td>
<td>0.21</td>
<td>0.27</td>
<td>0.26</td>
<td>0.31</td>
<td>0.26</td>
<td>0.26</td>
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<td>Peg to pod ratio</td>
<td>0.71</td>
<td>0.60</td>
<td>0.63</td>
<td>0.51</td>
<td>0.62</td>
<td>0.61</td>
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<tr>
<td>Number mature pod per plant</td>
<td>24.53</td>
<td>22.70</td>
<td>23.85</td>
<td>21.68</td>
<td>20.48</td>
<td>22.65</td>
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<tr>
<td>Number immature pod per plant</td>
<td>2.45</td>
<td>2.23</td>
<td>2.50</td>
<td>1.68</td>
<td>2.68</td>
<td>2.22</td>
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<tr>
<td>100 kernels weight</td>
<td>38.68</td>
<td>36.25</td>
<td>37.68</td>
<td>35.50</td>
<td>30.25</td>
<td>35.67</td>
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<tr>
<td>Shelling outturn</td>
<td>61.25</td>
<td>56.75</td>
<td>58.28</td>
<td>53.25</td>
<td>51.00</td>
<td>56.11</td>
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<tr>
<td>Oil (%)</td>
<td>49.51</td>
<td>48.50</td>
<td>48.40</td>
<td>48.10</td>
<td>48.29</td>
<td>48.56</td>
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<tr>
<td>Pod yield (Kg per hectare)</td>
<td>1809.00</td>
<td>1665.00</td>
<td>1774.00</td>
<td>1611.00</td>
<td>1517.00</td>
<td>1675.00</td>
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<tr>
<td>Biological Yield (%)</td>
<td>6206.00</td>
<td>5745.00</td>
<td>6022.00</td>
<td>5200.00</td>
<td>5693.00</td>
<td>5425.00</td>
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</tbody>
</table>

**Table 2: Effect of Brassinosteroid and Salicylic acid concentrations at reproductive stage**

<table>
<thead>
<tr>
<th>Observations</th>
<th>Brassinosteroid</th>
<th>Salicylic acid</th>
<th>Control</th>
<th>Mean (S.E)</th>
<th>CD at 5%</th>
<th>CV%</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of branches per plant</td>
<td>9.18</td>
<td>8.88</td>
<td>8.90</td>
<td>8.43</td>
<td>7.30</td>
<td>8.54</td>
</tr>
<tr>
<td>40 % flowering in Ground nut</td>
<td>50.00</td>
<td>49.00</td>
<td>49.00</td>
<td>49.00</td>
<td>50.00</td>
<td>49.40</td>
</tr>
<tr>
<td>Partitioning of dry matter %</td>
<td>2.18</td>
<td>2.06</td>
<td>1.63</td>
<td>1.74</td>
<td>2.00</td>
<td>1.92</td>
</tr>
<tr>
<td>Stem</td>
<td>14.59</td>
<td>15.38</td>
<td>15.18</td>
<td>14.59</td>
<td>16.88</td>
<td>15.34</td>
</tr>
<tr>
<td>Leaf</td>
<td>14.16</td>
<td>12.60</td>
<td>13.26</td>
<td>12.21</td>
<td>11.57</td>
<td>12.76</td>
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<tr>
<td>Pod</td>
<td>64.58</td>
<td>59.56</td>
<td>61.84</td>
<td>57.93</td>
<td>56.48</td>
<td>60.08</td>
</tr>
<tr>
<td>Fertility index</td>
<td>0.21</td>
<td>0.26</td>
<td>0.23</td>
<td>0.30</td>
<td>0.24</td>
<td>0.25</td>
</tr>
<tr>
<td>Peg to pod ratio</td>
<td>0.76</td>
<td>0.62</td>
<td>0.70</td>
<td>0.52</td>
<td>0.67</td>
<td>0.65</td>
</tr>
<tr>
<td>Number immature pod per plant</td>
<td>2.40</td>
<td>2.30</td>
<td>2.00</td>
<td>1.85</td>
<td>2.80</td>
<td>2.26</td>
</tr>
<tr>
<td>100 kernels weight</td>
<td>41.00</td>
<td>37.63</td>
<td>39.00</td>
<td>35.08</td>
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<td>Shelling outturn</td>
<td>61.78</td>
<td>59.70</td>
<td>61.48</td>
<td>53.20</td>
<td>51.38</td>
<td>57.51</td>
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<tr>
<td>Oil (%)</td>
<td>48.82</td>
<td>48.43</td>
<td>48.16</td>
<td>47.20</td>
<td>47.87</td>
<td>48.09</td>
</tr>
<tr>
<td>Pod yield (Kg per hectare)</td>
<td>1935.00</td>
<td>1838.00</td>
<td>1864.00</td>
<td>1767.00</td>
<td>1603.00</td>
<td>1801.00</td>
</tr>
<tr>
<td>Biological Yield (%)</td>
<td>5855.00</td>
<td>5493.00</td>
<td>5706.00</td>
<td>5030.00</td>
<td>5043.00</td>
<td>5425.00</td>
</tr>
</tbody>
</table>

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Treatments at vegetative stage: The difference in the fruiting efficiency as influenced by growth regulators were statistically non-significant. The values of fruiting efficiency are as follows; 0.149, 0.157, 0.157, 0.161, 0.159 and 0.159 in Bs @ 10 M, BS @15 ppm, SA @ 300 ppm, SA @ 500pm and control, respectively. 

Fertility index: Higher concentration of SA significantly increased fertility index (peg to flower ratio) over control but lower concentrations resulted in poor fertility index at both stages. Therefore higher concentration increase conversion of flowers to pegs. 

Pod to peg ratio

Treatments at vegetative stage: The lower concentrations of growth regulators particularly BS significantly increased pod to peg ratio. The highest pod to peg ratio of 0.709 was observed in BS @10ppm.

Treatments at reproductive stage: The spray of growth regulators especially BS at vegetative and reproductive stages significantly increased pod to peg ratio, where the lower concentrations were most effective.

Total Number of Mature Pods: There was considerable increase in total number of mature pod per plants in growth regulators treated plants than control. 1 pm Bs treatment was the most effective, which resulted in 25.25 pods per plant as against 21.32 pods per plant in control. The lower concentration of BS and SA gave higher number of pods per plants than the higher concentrations. The spray of lower concentration of both BS and Sa at either stage recorded significantly higher pods as compared to control. This increase may be due to more peg penetration in growth regulator treated plants, there translation in greater number of pods implying that there might have been maximum pod setting in the plants sprayed with bioregulators which has evident from pod to peg ratio in the latter. These results are strongly supported by the findings of Prakash et al., (2003), who found similar results with the spray of HBR @ 1. Mg/L at flowering and pegging stage, increased the pods per plant in ground nut. As per the findings of Singh et al., (1982) SA increased the number of pods per plant in groundnut.

Total Number of Immature Pods

Treatments at vegetative stage: The spray of growth regulators on groundnut plant at vegetative stage significantly reduced the number of immature pods per plants as compared to control.

Treatments at reproductive stage: The best treatment among all the growth regulators was SA @ 500ppm which produced only 1.85 immature pods. Higher concentration may be inhibitory and that lower concentrations were promontory with respect to conversion of immature pods as compared to control, and hence the number of immature pods were more than the higher concentration and less than the control, in the lower concentration.

100 Kernel Weight: Treatments with all the growth regulators at reproductive stage significantly increased the 100 kernel weight over control. The differences in 100 kernel weight between growth regulators and control were statistically significant. The stages of application of and concentration of both the growth regulators differed with respect to 100 kernel weight. Application of 40 ppm BS at reproductive stage has been reported to increase test weight in wheat cultivars (Sairam et al., 1996); in green gram (Takahashi et al., 1994); in ground nut (Vardhini and Rao, 1998). They concluded that BS treatment might have resulted in an increase in assimilate transport from source to sink (pods) and their ultimate conversion into economic yield. Perbodh Chander et al. (1988) and Dutta and Nanda (1978) have reported increase in test weight in plants treated with SA, sprayed at reproductive stage in mung bean and cheena millet, respectively.

Shelling outturn (Percent): Growth regulators significantly increased the shelling outturn over control (water spray). The highest outturn was observed in BS @ 10ppm and SA @ 300ppm with 61.78 and 61.48 per cent respectively. The lower concentration of growth regulators were more effective than higher ones in increasing the shelling outturn.

Oil (percent): The growth regulators treatments at vegetative stage were not effective either to increase or decrease the oil per cent over control. Similar results were obtained in growth regulators treatments at reproductive stage.

Pod yield (kg per hectare): The spray of growth regulators at vegetative and reproductive stage effectively increased pod yield over respective control. Both the growth regulators were more effective at reproductive stage as compared to vegetative stage. Increase values of pod yields bioregulators were due to high dry matter partitioning towards the developing sink (pod), synchrony of flowering as evident from the time taken to 40 per cent flowering, more flower production and more od setting at early stage; the set pod get maximum period for development and resulted in higher kernel weight. The results positively supported by Ramraj et al. (1997), who also revealed that the application of lower concentration of BS at reproductive stage resulted in significant and substantial increase in seed yield. The yield enhancement by BS was also observed by other workers in ground nut (Vardhiniand and Rao, 1998; Li et al., 1993). A significant increase in yield of soybean was observed in SA treated plants over those of control (Pramod Kumar et al., 1999). P. Jayalakshmi et al. (2010) reported similar findings in groundnut.

Biological yield: From the results it appeared that the treatments at vegetative stage were more effective than at reproductive stage. The lower concentrations registered tremendous increase in biological yield in growth regulator-treated plants over control plants suggested the tendency of ground nut plants treated with growth regulators to accumulate high biomass throughout life cycle, a desirable trait needed for yield increase. The present result is supported by Reddy et al. (2002), who reported increased biomass production in mung bean treated with SA. Ravichandran and Pathmanabhan (2000) reported the highest biological yield in pearl millet treated with BS @ 0.1ppm

Harvest index: Differences due to spraying treatments at vegetative stage as well as reproductive stage with respect to harvest index were not significant. Similar findings were reported by Reddy et al. (2002) and Ravichandran and Pathmanabhan (2000). However at vegetative and reproductive stage highest value were obtained by BS @ 10, BS @15, SA @300, SA @500 ppm and control respectively.
REFERENCES


