Biological Forum – An International Journal **14(4a): 273-278(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Influence of the Foliar Application of Salicylic Acid and Zinc Sulphate on Biochemical Parameters and Yield Attributes of Groundnut (*Arachis hypogaea* L.)

Palandurkar Bhairavee Prakash[1], Prashant V. Shende[2], Sapana B. Baviskar[3] and Prema R. Manapure[2]
[1]M.Sc. Research Scholar, Section of Agricultural Botany,
College of Agriculture, Nagpur (University- Dr. PDKV, Akola) (Maharashtra), India.
[2]Associate Professor, Section of Agricultural Botany,
College of Agriculture, Nagpur (University- Dr. PDKV, Akola) (Maharashtra), India.
[3]Assistant Professor, Section of Agricultural Botany,
College of Agriculture, Nagpur (University- Dr. PDKV, Akola) (Maharashtra), India.

(Corresponding author: Palandurkar Bhairavee Prakash)*
(Received 07 September 2022, Accepted 11 November, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: In the present scenario of Climate Change, in the case of the Vidarbha region, in India and the world as a whole; the major problem is erratic rainfall. Especially in the case of *Kharif* groundnut (which is mostly dependent on rainfall); which makes it susceptible to moisture stress; leading to low nutrient uptake and therefore yields poor. Therefore, A field trial was conducted at the farm of Agril. Botany, College of Agriculture, Nagpur during *Kharif* season 2021 to study the influence of the foliar application of salicylic acid and zinc sulphate on biochemical parameters and yield attributes of groundnut (*Arachis hypogaea* L.). The experiment was carried out in randomized block design and replicated thrice consisting of twelve treatments of salicylic acid (50, 100, 150 ppm) and zinc sulphate (0.50%, 1.00%) applied individually and in combinations. It can be concluded that foliar spray of salicylic acid and zinc sulphate at 30 and 50 DAS helps to maintain the turgidity of the plant and that leads to appropriate nutrient uptake; that significantly enhanced the biochemical parameters viz., total chlorophyll content in leaf, oil content in the kernel, nitrogen content in leaves and yield attributes *viz*., the number of pods plant^{-1}, pod yield plant^{-1} (g), plot^{-1} (Kg), ha^{-1} (q), seed yield ha^{-1} (q). Among the treatments application of 100 ppm and 150 ppm salicylic acid with 1.00% of zinc sulphate gave significantly higher results in all parameters studied.

Keywords: Salicylic acid, zinc sulphate, groundnut, biochemical, foliar spray, yield, oil content.

INTRODUCTION

Groundnut oil has several uses but it is mainly used as cooking oil. Groundnut kernel contains about 47-49% oil and 20-25% protein. Its kernel as a whole is highly digestible. The kernels are eaten as either roasted or fried and salted.

The biological value of the groundnut protein is among the highest of the vegetable protein and equals that of casein. Groundnut oil is famous for its use in the human diet. Groundnut oil is primarily used in the manufacturing of vegetable ghee. Groundnut is a good source of all B vitamins except B12. They are a rich source of thiamine, riboflavin, nicotinic acid, and vitamin E. 1 g kernel supplies 5-8 food calories.

Salicylic acid leads to increased plant tolerance to stresses caused by high and very low temperatures and high salinity and plays an important role in plant resistance to pathogens. Salicylic acid also has important effects on important physiological processes related to plant development and growth in normal conditions, including controlling the transfer and absorption of ions, speeding up the formation of carotene and chlorophyll pigments, the permeability of cellular membranes, accelerating photosynthesis and increasing the activity of some important enzymes (AL-Mafargy *et al*., 2020).

Zinc participates in many physiological functions within the plant, as it contributes to the formation of the amino acid (Tryptophan), which is the origin of auxins in the plant and is necessary for the elongation of cells. It is also an important and necessary component of phosphorylation and the formation of glucose. Zinc also participates effectively in other vital functions, including its role in the metabolism of nucleic acids RNA and DNA. It also increases vitamin C and a complex vitamin of the B group. In addition to its contribution to the formation of pollen and the formation of chlorophyll, it also increases the plant's ability to absorb several elements from the soil (AL-Mafargy *et al*., 2020).

Meena *et al.* (2020) conducted a field experiment to study the evaluation of hydrogel and salicylic acid application effect on yield, quality, economics and water-use efficiency of Indian mustard (*Brassica juncea*) in restricted irrigation conditions of SE Rajasthan. The experiment consists of 12 treatment combinations. Among treatments spray of salicylic acid 200 ppm at flowering and siliqua formation stage significantly increased oil content (38.58 %), siliqua plant^{-1} (186.78), seeds siliqua^{-1} (15.05), 1000-seed weight (5.12 g), seed yield (2242.29 kg ha^{-1}) and harvest index (32.44%).

Shemi *et al.* (2021) studied the effects of salicylic acid, zinc and glycine betaine on morpho-physiological growth and yield of maize under drought stress. This experiment revealed that the spraying application of 140 mg l^{-1} SA, 4 g l^{-1} Zn, and 11.5 g l^{-1} GB improved chlorophyll a, chlorophyll b and total chlorophyll content yield and its components such as the number of grains plant^{-1}, 100-grain weight (g), biological yield plant^{-1} (g), grain yield plant^{-1} (g) and harvest index (%) in both (well-watered and water deficit) soil conditions.

Vinita *et al.* (2022) studied the effect of foliar application of micronutrients on chemical, and biochemical parameters and yield attributes in chickpeas (*Cicer arietinum* L.). Results revealed that foliar application of zinc sulphate @ 0.50% significantly improves total leaf chlorophyll content (mg g^{-1}) and leaf nitrogen content (%), number of pods plant^{-1}, the weight of pods plant^{-1} (g), number of seeds plant^{-1}, test weight (g), seed yield plant^{-1} (g) and seed yield ha^{-1} (q); when compared with control.

Kesarkar *et al.* (2022) studied the effect of foliar application of iron and zinc on morpho-physiological parameters and yield of safflower (*Carthamus tinctorius* L.). The result showed that foliar application of zinc sulphate @ 1.0% significantly improves the oil content, seed yield plot^{-1} (Kg), and harvest index (%); when compared to the control.

Monga and Kumar (2022) studied the effect of potassium nitrate and salicylic acid on yield, yield attributes and economics of wheat (*Triticum aestivum* L.). The result showed that the application of salicylic acid @ 100 ppm significantly increased the length of a spike (cm), number of grains spike^{-1}, 1000 grain weight (g) and grain yield (q ha^{-1}) when compared to the control.

MATERIAL AND METHODS

The present study was conducted at the farm of Agril. Botany Section, College of Agriculture, Nagpur. Treatments comprising T_1- Control (water spray), T_2 (Salicylic acid @ 50 ppm), T_3 (Salicylic acid @ 100 ppm), T_4 (Salicylic acid @ 150 ppm), T_5 (Zinc Sulphate @ 0.50%), T_6 (Zinc Sulphate @ 1.00%), T_7 (Salicylic acid @ 50 ppm + Zinc Sulphate @ 0.50%), T_8 (Salicylic acid @ 50 ppm + Zinc Sulphate @ 1.00%), T_9 (Salicylic acid @ 100 ppm + Zinc Sulphate @ 0.50%), T_{10} (Salicylic acid @ 100 ppm + Zinc Sulphate @ 1.00%), T_{11} (Salicylic acid @ 150 ppm + Zinc Sulphate @ 0.50%), T_{12} (Salicylic acid @ 150 ppm + Zinc sulphate @ 1.00%) were evaluated in a randomised block design with three replication. Each plot measured 3.15 m × 2.20 m gross and 2.25 m × 2.00 m with a spacing of 45 cm × 10 cm. At 30 and 50 DAS, two foliar sprays of salicylic acid and zinc sulphate were given as per treatment. In the present study; analysis of total chlorophyll content and nitrogen content of leaves in groundnut were taken at 40, 60 and 80 DAS. Estimation of oil content in the kernel was done after harvesting. The total chlorophyll content of oven-dried leaves was estimated by a colorimetric method as suggested by Bruinsma (1982). Nitrogen content in leaves was estimated by micro-kjeldhal's method given by Somichi *et al*, 1972. The oil content of groundnut cultivars was estimated by Soxhlet's procedure described by Sankaran (1965). Data was estimated by statistical analysis as per the method suggested by Panse and Sukhatme (1958).

RESULTS AND DISCUSSION

Total chlorophyll content in leaf (mg g^{-1}). At 40, 60 and 80 DAS, data regarding total chlorophyll content in leaves was found significant. However, the treatment T_{12} (Salicylic acid @ 150 ppm + Zinc sulphate @ 1.00%) was found significantly superior over the treatment T_1 (control) and other treatments; followed by treatment T_{10} (Salicylic acid @ 100 ppm + Zinc Sulphate @ 1.00%), T_{11} (Salicylic acid @ 150 ppm + Zinc Sulphate @ 0.50%), T_8 (Salicylic acid @ 50 ppm + Zinc Sulphate @ 1.00%), T_9 (Salicylic acid @ 100 ppm + Zinc Sulphate @ 0.50%) and T_7 (Salicylic acid @ 50 ppm + Zinc Sulphate @ 0.50%). Whereas, the treatments T_2 (Salicylic acid @ 50 ppm), T_3 (Salicylic acid @ 100 ppm), T_4 (Salicylic acid @ 150 ppm), T_5 (Zinc Sulphate @ 0.50%) and T_6 (Zinc Sulphate @ 1.00%) were found at par with control.

From the above data, it was revealed that total chlorophyll content in leaves is observed at three different stages *i.e.,* 40, 60 and 80 DAS of groundnut crop. At 60 DAS total chlorophyll content in leaves is significantly more as compared to the two other stages of observations. At 80 DAS total chlorophyll content in leaves starts decreasing gradually. This may be due to the follow-up of the maturity stage of the groundnut crop after 80 DAS and onwards.

A field experiment was conducted by Abd-Elkader (2016). The best results of chemical constituents were achieved when garlic plants were sprayed with 20 % micronutrient and 300 ppm salicylic acid. The obtained results showed that the foliar spraying 300 ppm salicylic acid increases the leaf's total chlorophyll content (59.42 SPAD) of garlic plants. Whereas, Nandi *et al*. (2020) examined spraying of Zn at a concentration of 0.75% significantly increases the chlorophyll content of leaves in groundnut and similarly Vinita *et al.,* (2022) revealed that foliar application of zinc sulphate @ 0.50% significantly improves total leaf chlorophyll content (mg g^{-1}) in chickpea (*Cicer arietinum* L.).

Oil content in the kernel (%). The data relating to the oil content of groundnut kernel were recorded after harvesting the crop. Data regarding oil content in the kernel was found significant. The range of oil content in the kernel was recorded at 48.11% to 49.53%. However, the treatment T_{12} (Salicylic acid @ 150 ppm + Zinc sulphate @ 1.00%) was found significantly superior over the treatment T_1 (control) and other treatments; followed by treatment T_{10} (Salicylic acid @ 100 ppm + Zinc Sulphate @ 1.00%), T_{11} (Salicylic acid @ 150 ppm + Zinc Sulphate @ 0.50%), T_8 (Salicylic acid @ 50 ppm + Zinc Sulphate @ 1.00%), T_9 (Salicylic acid @ 100 ppm + Zinc Sulphate @ 0.50%) and T_7 (Salicylic acid @ 50 ppm + Zinc Sulphate @ 0.50%). Whereas, the treatments T_2 (Salicylic acid @ 50 ppm), T_3 (Salicylic acid @ 100 ppm), T_4 (Salicylic acid @ 150 ppm), T_5 (Zinc Sulphate @ 0.50%) and T_6 (Zinc Sulphate @ 1.00%) were found at par with control.

From the above data it can be concluded that, foliar application of salicylic acid and zinc sulphate at two different growth stages helps significantly; to retain and a slight increase in the oil content in the kernel of groundnut of variety PDKVG335; which has originally the range of oil content of 48-49%; which can be called one of the highest among the groundnut varieties.

Hence, although the quality parameter of a crop such as oil content in a seed is genetically controlled; at the same time plant nutrition and growth regulators have a considerable impact on the expression of quality parameters. Therefore, it is essential to take care judicially for the nutrient supply and growth regulators of plants at the flowering, pod formation and seed formation stage.

Similar results were found by Jadhav *et al*. (2013). Foliar application of SA @ 100 ppm shows the highest oil content (47.90%) in groundnut seeds of *cv.* SB-11 over control. Whereas, El-Habbasha (2015) showed that increasing foliar zinc application from 0 to 1000 mg l^{-1} increased all biochemical parameters such as oil content in groundnut seed, with the two nitrogen rates (60 and 120 N kg ha^{-1}) and Kesarkar *et al.* (2022) showed that foliar application of zinc sulphate @ 1.0% improved the oil content in safflower (*Carthamus tinctorius* L.).

Nitrogen content in leaves (%). At 40, 60 and 80 DAS, data regarding nitrogen content in leaves was found significant. The range of nitrogen content in leaves was recorded from 3.79% to 4.60%. However, the treatment T_{12} (Salicylic acid @ 150 ppm + Zinc sulphate @ 1.00%) was found significantly superior over the control; followed by treatment T_{10} (Salicylic acid @ 100 ppm + Zinc Sulphate @ 1.00%), T_{11} (Salicylic acid @ 150 ppm + Zinc Sulphate @ 0.50%), T_8 (Salicylic acid @ 50 ppm + Zinc Sulphate @ 1.00%), T_9 (Salicylic acid @ 100 ppm + Zinc Sulphate @ 0.50%) and T_7 (Salicylic acid @ 50 ppm + Zinc Sulphate @ 0.50%). Whereas; the treatments T_2 (Salicylic acid @ 50 ppm), T_3 (Salicylic acid @ 100 ppm), T_4 (Salicylic acid @ 150 ppm), T_5 (Zinc Sulphate @ 0.50%) and T_6 (Zinc Sulphate @ 1.00%) were found at par with control.

From the above data, it was revealed that nitrogen content in leaves is observed at three different stages *i.e.,* 40, 60 and 80 DAS of groundnut crop. At 60 DAS nitrogen content in leaves is significantly more as compared to two other stages of observations. At 80 DAS nitrogen content in leaves starts decreasing gradually. This may be due to the follow-up of the maturity stage of the groundnut crop after 80 DAS and onwards.

The decrease in nitrogen content might be due to the fact that younger leaves and developing organs, such as grains act as strong sink demand and may draw heavily nitrogen from older leaves (Gardner *et. al.*, 1988).

A field experiment was conducted by Abd-Elkader (2016). The best results of chemical constituents were achieved when garlic plants were sprayed with 20 % micronutrient and 300 ppm salicylic acid. The obtained results showed that the foliar spraying 300 ppm salicylic acid increases the leaf's nitrogen content (1.96 %) of garlic plants. Whereas, Vinita *et al.* (2022) reported that foliar application of zinc sulphate @ 0.50% significantly improves leaf nitrogen content (%) in chickpeas (*Cicer arietinum* L.). Similarly, AL-Mafargy *et al.* (2020) show that the treatment combinations of Zn 100 mg l^{-1} and SA 150 mg l^{-1} shows the highest concentration of Nitrogen (1.767%) in leaves of the cherry tomato plant and Nandi *et al*. (2020) showed that Spraying of Zn at a concentration of 0.75% significantly increases nitrogen (mg g^{-1}) content in pods of groundnut.

Number of pods plant^{-1}. Data regarding the number of pods plant^{-1} was found significant. The range of the number of pods plant^{-1} was recorded from 17.53 to 23.74. However, the treatment T_{12} (Salicylic acid @ 150 ppm + Zinc sulphate @ 1.00%) was found significantly superior over the treatment T_1 (control) and other treatments; followed by treatment T_{10} (Salicylic acid @ 100 ppm + Zinc Sulphate @ 1.00%), T_{11} (Salicylic acid @ 150 ppm + Zinc Sulphate @ 0.50%), T_8 (Salicylic acid @ 50 ppm + Zinc Sulphate @ 1.00%), T_9 (Salicylic acid @ 100 ppm + Zinc Sulphate @ 0.50%) and T_7 (Salicylic acid @ 50 ppm + Zinc Sulphate @ 0.50%). Whereas, the treatments T_2 (Salicylic acid @ 50 ppm), T_3 (Salicylic acid @ 100 ppm), T_4 (Salicylic acid @ 150 ppm), T_5 (Zinc Sulphate @ 0.50%) and T_6 (Zinc Sulphate @ 1.00%) were found at par with control.

Foliar spray of salicylic acid and zinc sulphate at concentrations of 150 ppm and 1.00% respectively exhibited the best results among all treatments. The range of the number of pods plant^{-1} was 17.53 (Control) to 23.74 (Salicylic acid @ 150 ppm + Zinc sulphate @ 1.00%).

Similar results were found with Ali and Mahmoud (2013). The results showed that foliar application of salicylic Acid (SA) (150 ppm) and zinc sulphate (400 or 500 ppm) enhanced significantly ($p<0.05$) the number of pods plant^{-1}. Whereas, Vinita *et al.*, (2022) reported that foliar application of zinc sulphate @ 0.50% significantly improves the number of pods plant^{-1} in chickpeas (*Cicer arietinum* L.) and Monga and Kumar (2022) showed that application of salicylic acid @ 100 ppm significantly increased length of a spike (cm), number of grains spike^{-1} in wheat (*Triticum aestivum* L.).

Pod yield plant^{-1} (g), plot^{-1} (Kg), ha^{-1} (q). Data indicated that pod yield plant^{-1} (g) was found significant. The range of pod yield plant^{-1} (g) was recorded from 8.64 g to 11.32 g. However, the treatment T_{12} (Salicylic acid @ 150 ppm + Zinc sulphate @ 1.00%) was found significantly superior over the treatment T_1 (control) and other treatments; followed by treatment T_{10} (Salicylic acid @ 100 ppm + Zinc Sulphate @ 1.00%), T_{11} (Salicylic acid @ 150 ppm + Zinc Sulphate @ 0.50%), T_8 (Salicylic acid @ 50 ppm + Zinc Sulphate @ 1.00%), T_9 (Salicylic acid @ 100 ppm + Zinc Sulphate @ 0.50%) and T_7 (Salicylic acid @ 50 ppm + Zinc Sulphate @ 0.50%). Whereas, the treatments T_2 (Salicylic acid @ 50 ppm), T_3 (Salicylic acid @ 100 ppm), T_4 (Salicylic acid @ 150 ppm), T_5 (Zinc Sulphate @ 0.50%) and T_6 (Zinc Sulphate @ 1.00%) were found at par with control.

Pod yield plot^{-1} (Kg) and ha^{-1} (q) were found significant. The range of pod yield plot^{-1} (Kg) was recorded at 1.18 Kg to 1.55 Kg. Similarly, the range of pod yield ha^{-1} (q) in groundnut was recorded at 26.22 q to 34.44 q. However, the treatment T_{12} (Salicylic acid @ 150 ppm + Zinc sulphate @ 1.00%) was found significantly superior over the treatment T_1 (control) and other treatments; followed by treatment T_{10} (Salicylic acid @ 100 ppm + Zinc Sulphate @ 1.00%), T_{11} (Salicylic acid @ 150 ppm + Zinc Sulphate @ 0.50%), T_8 (Salicylic acid @ 50 ppm +Zinc Sulphate @ 1.00%), T_9 (Salicylic acid @ 100 ppm + Zinc Sulphate @ 0.50%) and T_7 (Salicylic acid @ 50 ppm + Zinc Sulphate @ 0.50%). Whereas; the treatment T_2 (Salicylic acid @ 50 ppm), T_3 (Salicylic acid @ 100 ppm), T_4 (Salicylic acid @ 150 ppm), T_5 (Zinc Sulphate @ 0.50%) and T_6 (Zinc Sulphate @ 1.00%) were found at par with control.

Similar results were obtained by Rabari *et al*. (2018) revealed that application of $ZnSO_4$ @ 8 Kg ha^{-1} and foliar spray of $ZnSO_4$ @ 0.5% increases the pod yield (3878 Kg ha^{-1}, 3444 Kg ha^{-1} respectively) in groundnut (*Arachis hypogaea* L). And also, Badr and Fayed (2020) reported that treatment of salicylic 0.25 g l^{-1} and microelements 1 g l^{-1} significantly improves seeds pod^{-1} (9.65), pods plant^{-1} (15.91), green pod yield plant^{-1} (92.34 g), dry seed yield plant^{-1} (28.13 g) in Pea (*Pisum sativum* L.). Whereas, Monga and Kumar (2022) showed that the application of salicylic acid @ 100 ppm significantly increased grain yield (q ha^{-1}) when compared to control in wheat (*Triticum aestivum* L.).

Seed yield ha^{-1} (q). Source-sink relation contributes to seed yield. It includes phloem loading at the source (leaf) and unloading at the sink (seed) by which the economic part will be getting the assimilates synthesized by photosynthesis. Partitioning of the assimilates in the plant during reproductive development is important for flowers, fruit and seeds. Thus, crop yield can be increased either by increasing the total dry matter production or by increasing the proportion of economic yield (harvest index) or both (*Gardner et al.*, 1988).

Seed yield ha^{-1} (q) in groundnut was found significant. The range of seed yield ha^{-1} (q) in leaves was recorded from 19.67 q to 25.83 q. However, the treatment T_{12} (Salicylic acid @ 150 ppm + Zinc sulphate @ 1.00%) was found significantly superior over the treatment T_1 (control) and other treatments; followed by treatment T_{10} (Salicylic acid @ 100 ppm + Zinc Sulphate @ 1.00%), T_{11} (Salicylic acid @ 150 ppm + Zinc Sulphate @ 0.50%), T_8 (Salicylic acid @ 50 ppm +Zinc Sulphate @ 1.00%), T_9 (Salicylic acid @ 100 ppm + Zinc Sulphate @ 0.50%) and T_7 (Salicylic acid @ 50 ppm + Zinc Sulphate @ 0.50%). Whereas, the treatments T_2 (Salicylic acid @ 50 ppm), T_3 (Salicylic acid @ 100 ppm), T_4 (Salicylic acid @ 150 ppm), T_5 (Zinc Sulphate @ 0.50%) and T_6 (Zinc Sulphate @ 1.00%) were found at par with control.

From the above data, it is revealed that foliar spray of salicylic acid and zinc sulphate at concentrations of 150 ppm and 1.00% respectively exhibited the best results among all treatments.

The highest per cent increase in yield (31.33%) over control was observed by the application of 150 ppm salicylic acid + 1.00% zinc sulphate as a foliar spray at 30 and 50 DAS. Next to this treatment foliar spray of 100 ppm salicylic acid + 1.00% zinc sulphate also enhanced the yield by (27.09%) over control. The yield was increased by this treatment over control with a B:C ratio of 2.66 and 2.58 respectively.

Similar results were obtained with Ali and Mahmoud (2013). The results showed that foliar application of salicylic Acid (SA) enhanced significantly ($p < 0.05$) seed weight plant^{-1} and seed yield ha^{-1} as compared with control (untreated plants) and the superiority was due to the high SA concentration (150 ppm). Significant ($p < 0.05$) increases in all above mention traits also occurred with foliar application of zinc (400 or 500 ppm) in mungbean. Whereas, Kesarkar *et al.* (2022) reported that, foliar application of zinc sulphate @ 1.0% significantly improves the seed yield plot^{-1} (Kg) in safflower (*Carthamus tinctorius* L.). Similarly, Monga and Kumar (2022) reported that the application of salicylic acid @ 100 ppm significantly increased the number of grains spike^{-1}, grain yield (q ha^{-1}) wheat (*Triticum aestivum* L.).

Test weight (100 seeds) (g). Data regarding test weight was recorded maximum in treatment T_{12} (Salicylic acid @ 150 ppm + Zinc sulphate @ 1.00%) when compared with treatment T_1 (control) and other treatments. The range of test weight was recorded from 38.27 g to 39.49 g.

However, data regarding test weight in groundnut came non-significant. But, at the same time, it can be concluded that; foliar application of salicylic acid and zinc sulphate helps to attend the highest limit of the test weight of variety PDKVG-335; which is at the range of 35-40 g; which is one of the highest ranges in groundnut varieties.

Harvest index (%). Data were found statistically significant. Significantly maximum harvest index was recorded in T_{12} (Salicylic acid @ 150 ppm + Zinc sulphate @ 1.00%) when compared with treatment T_1 (control) and other treatments; followed by treatment T_{10} (Salicylic acid @ 100 ppm + Zinc Sulphate @ 1.00%), T_{11} (Salicylic acid @ 150 ppm + Zinc Sulphate @ 0.50%), T_8 (Salicylic acid @ 50 ppm + Zinc Sulphate @ 1.00%), T_9 (Salicylic acid @ 100 ppm + Zinc Sulphate @ 0.50%) and T_7 (Salicylic acid @ 50 ppm + Zinc Sulphate @ 0.50%). Whereas, the treatments T_2 (Salicylic acid @ 50 ppm), T_3 (Salicylic acid @ 100 ppm), T_4 (Salicylic acid @ 150 ppm), T_5 (Zinc Sulphate @ 0.50%) and T_6 (Zinc Sulphate @ 1.00%) were found at par with control.

Similar results were obtained with Meena *et al.* (2020) reported that a spray of salicylic acid 200 ppm at the flowering and siliqua formation stage significantly increased the harvest index (32.44%) in Indian mustard (*Brassica juncea*). Similarly, Shemi *et al.* (2021) reported that the spraying application of 140 mg l^{-1} SA, 4 g l^{-1} Zn, and 11.5 g l^{-1} GB improved yield and its components such as harvest index (%) in both (well-watered and water deficit) soil conditions in maize. Similarly, Kesarkar *et al.* (2022) reported that foliar application of zinc sulphate @ 1.0% significantly improves the harvest index (%) in safflower (*Carthamus tinctorius* L.).

Table 1: Effect of Salicylic acid and Zinc sulphate on total chlorophyll content of leaf, oil content in kernel, nitrogen content in leaves, number of pods plant^{-1}, pod yield plant^{-1} (g), plot^{-1} (Kg), ha^{-1} (Kg), seed yield ha^{-1} (q), test weight and harvest index in groundnut.

Treatments	Total Chlorophyll content in leaf (mg g^{-1})			Oil content in kernel (%)	Nitrogen content in leaves (%)			Number of pods plant^{-1}	Pod yield plant^{-1} (g)	Pod yield plot^{-1} (kg)	Pod yield ha^{-1} (q)	Seed yield ha^{-1} (q)	Test weight (100 seeds) (g)	Harvest index (%)
	40 DAS	60 DAS	80 DAS		40 DAS	60 DAS	80 DAS							
T1(Control)	1.27	1.51	1.42	48.11	2.89	3.83	3.79	17.53	8.64	1.18	26.22	19.67	38.27	29.51
T2 (Salicylic acid @ 50 ppm)	1.34	1.59	1.42	48.34	3.05	4.08	3.98	18.21	9.26	1.22	27.11	20.33	38.63	30.47
T3 (Salicylic acid @ 100 ppm)	1.36	1.61	1.43	48.36	3.11	4.12	4.08	18.43	9.50	1.26	28.00	21.00	39.06	31.11
T4 (Salicylic acid @ 150 ppm)	1.40	1.66	1.47	48.40	3.14	4.16	4.11	19.45	9.82	1.30	28.89	21.67	39.12	32.09
T5 (Zinc Sulphate @ 0.50%)	1.40	1.70	1.49	48.39	3.16	4.22	4.18	19.23	10.26	1.33	29.56	22.17	39.10	31.63
T6 (Zinc Sulphate @ 1.00%)	1.45	1.77	1.57	48.45	3.26	4.28	4.22	19.93	10.34	1.40	31.11	23.33	39.13	32.21
T7 (Salicylic acid @ 50 ppm + Zinc Sulphate @ 0.50%)	1.43	1.72	1.54	49.43	3.19	4.25	4.20	20.50	10.38	1.37	30.44	22.83	39.14	32.59
T8 (Salicylic acid @ 50 ppm +Zinc Sulphate @ 1.00%)	1.39	1.82	1.55	49.39	3.31	4.33	4.27	22.38	10.83	1.45	32.22	24.17	39.29	34.17
T9 (Salicylic acid @ 100 ppm + Zinc Sulphate @ 0.50%)	1.38	1.78	1.51	49.38	3.22	4.28	4.24	21.94	10.56	1.42	31.56	23.67	39.20	32.82
T10 (Salicylic acid @ 100 ppm + Zinc Sulphate @ 1.00%)	1.52	1.89	1.63	49.52	3.38	4.40	4.34	23.42	11.23	1.50	33.33	25.00	39.41	36.49
T11 (Salicylic acid @ 150 ppm + Zinc Sulphate @ 0.50%)	1.47	1.85	1.64	49.47	3.34	4.36	4.31	23.09	11.09	1.47	32.67	24.50	39.34	35.83
T12 (Salicylic acid @ 150 ppm + Zinc Sulphate @ 1.00%)	1.53	1.94	1.67	49.53	3.74	4.77	4.60	23.74	11.32	1.55	34.44	25.83	39.49	38.61
SE (m) +	0.03	0.05	0.04	0.30	0.12	0.10	0.11	1.084	0.253	0.07	1.517	1.14	2.03	1.74
CD at 5%	0.10	0.14	0.11	0.88	0.33	0.31	0.31	3.178	0.742	0.20	4.45	3.34	--	5.11

CONCLUSION

Foliar application of salicylic acid and zinc sulphate at 30 and 50 DAS shows significant variations in nearly all studied characters except a few (test weight). Individual treatments of salicylic acid and zinc sulphate also show significant variation in all studied characters; when compared with control, but less effective than treatment combinations. Groundnut variety PDKVG-335 shows a positive response to foliar application (at 30 and 50 DAS) of salicylic acid and zinc sulphate. Among all the treatments under study; the treatment combination of salicylic acid and zinc sulphate shows a more significant increase in all studied characters; than individual applications of these two.The biochemical parameter such as chlorophyll content and nitrogen content in leaves shows significant variation and contributed to an increase in yield. Similarly, being an oilseed crop, the range of oil content in the kernel shows an increasing trend. The highest per cent increase in yield (31.33%) over control was observed by the application of salicylic acid @ 150 ppm + zinc sulphate @ 1.00% as a foliar spray at 30 and 50 DAS. Next to this treatment foliar spray of salicylic acid @ 100 ppm + zinc sulphate @ 1.00% also enhanced yield by 27.09% over control. The yield was increased by this treatment over control with a B:C ratio of 2.66 and 2.58 respectively. From the overall result, it can be stated that foliar application of salicylic acid and zinc sulphate with different concentrations improved biochemical and yield and yield contributing characters and might have helped in attaining better seed yield in the present investigation. Among treatment combinations; treatment T_{12} (Salicylic acid @ 150 ppm + Zinc sulphate @ 1.00%) and T_{10} (Salicylic acid @ 100 ppm + Zinc Sulphate @ 1.00%) show the highest significant increase in all studied characters; when applied at 30 and 50 DAS.

FUTURE SCOPE

This research work will help in finding out the characters which are strongly associated with biochemical parameters and yield of groundnut under the effect of salicylic acid and zinc sulphate. This can be profitably used by the farmers.

Acknowledgement. I extend my sincere thanks to Associate Prof. (Dr.) P. V. Shende (major advisor) and to my advisory committee members for giving me proper guidance throughout my study. I also sincerely thank Section of Agril. Botany, College of Agriculture, Nagpur for their kind cooperation and for providing facilities and resources during my P.G. programme.

Conflict of Interest. None.

REFERENCES

Abd-Elkader, D. Y. (2016). Effect of foliar spraying with micronutrients and salicylic acid on growth, yield and quality of garlic plants. *Alex. J. Agric. Sci., 61*(6), 649-658.

Ali, E. A. and Mahmoud, A. M. (2013). Effect of foliar spray by different salicylic acid and zinc concentrations on seed yield and yield components of mungbean in sandy soil. *Asian Journal of Crop Science, 5*(1), 33.

AL-Mafargy, O. K., Mohammed, H. A. and Omar, D. G. (2020). The spraying effect of zinc and salicylic acid and their combination on the growth and production of the cherry tomato plant. *Plant Arch., 20*(1), 2349-2354.

Badr, A. D. and Fayed, A. A. M. (2020). Effect of Foliar Application of some organic acids and microelements on pea (*Pisum sativum* L.) yield and seed quality and different fertilizer levels under salt-affected soil conditions. *J. Plant Production, 11*(12), 1597-1606.

Bruinsma, J. (1982). A comment on the spectrophotometric determination of chlorophyll. *Bio-chem., Bio-phy., Acta., 52,* 576-578.

El-Habbasha, S. F. (2015). Impact of nitrogen fertilizer and zinc foliar application on growth, yield, yield attributes and some chemical constituents of groundnut. *Int. J. Plant Soil Sci., 4*(3), 259-264.

Gardner, F. P., Pearce, R. B. and Mitchell, R. L. (1988). In: Physiology of Crop Giants. Lowa State University Press, Amen, Lowa, pp: 187-208.

Jadhav, S. H., Bhambudekar, S. B. and Patil, D. B. (2013). Effect of salicylic acid on fatty acid composition of groundnut seeds. National Conference of Plant Physiology. *Current Trends in Plant Biology Research*, 740-741.

Kesarkar, A. P., Shende, P. V., Karad, V. S., Manapure, P. R., Deotale, R. D. and Tupkar, S. D. (2022). Effect of foliar application of iron and zinc on morpho-physiological parameters and yield in safflower (*Carthamus tinctorius* L.). *J. Soils and Crops, 32*(1), 127-132.

Meena, B. S., Narolia, R. S., Meena, L. K., Meena, K. C. and Meena, S. N. (2020). Evaluation of hydrogel and salicylic acid application effect on yield, quality, Economics and Water-use efficiency of Indian Mustard (*Brassica juncea*) in Restricted Irrigation Condition of SE Rajasthan. *Int. J. Curr. Microbiol. App. Sci., 9*(5), 3274-3283.

Monga, R. and Kumar, R. (2022). Effect of foliar application of potassium nitrate and salicylic acid on yield, yield attributes and economics of wheat (*Triticum aestivum* L.). *J. Soils and Crops, 32*(1), 97-101.

Nandi, R., Reja, H., Chatterjee, N., Bag, A. G. and Hazra, G. C. (2020). Effect of Zn and B on the growth and nutrient uptake in groundnut. *Curr. J. App. Sci. Technol., 39*(1), 1-10.

Panse, V. G. and Sukhatme, P. V. (1954). Statistical methods for agricultural workers, I.C.A.R. Publication, New Delhi. 2nd Edn. pp. 63-66.

Rabari, K. V., Prajapati, B. K. and Nandre, B. M. (2018). Effect of micronutrients on growth and yield of groundnut (*Arachis hypogaea* L.). *GAU Res. J., 43*(2), 73-75.

Sankaran, A. (1965). A Laboratory manual of Agric. Chem. Asia Publ. Bombay. pp. 258.

Shemi, R., Wang, R., Gheith, E. S. M., Hussain, H. A., Hussain, S., Irfan, M., Cholidah, L., Zhang K. and Wang, L. (2021). Effects of salicylic acid, zinc and glycine betaine on morpho-physiological growth and yield of maize under drought stress. *Scientific Reports, 11*(1), 1-14.

Somichi, Y., Doughlus S. Y. and James, A. P. (1972). Laboratory manual. Physiological studies in rice analysis for total nitrogen (organic N) in plant tissue. *The Inter Res. Instti. Los Banos, Languna, Phillipine*: II.

Vinita, S. K., Shende, P. V., Kesarkar, A. P., Madke V. S. and Tupkar, S. D. (2022). Effect of foliar application of micronutrients on chemical, biochemical parameters and yield attributes in chickpea. *J. Soils and Crops, 32*(1), 184-192.

How to cite this article: Palandurkar Bhairavee Prakash, Prashant V. Shende, Sapana B. Baviskar and Prema R. Manapure (2022). Influence of the Foliar Application of Salicylic Acid and Zinc Sulphate on Biochemical Parameters and Yield Attributes of Groundnut (*Arachis hypogaea* L.). *Biological Forum – An International Journal, 14*(4a): 273-278.