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Sulphur Application Enhanced Yield in Groundnut (*Arachis hypogaea*) under Furrow Sowing Technique

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ABSTRACT

The field experiment was conducted at students' farm, Department of Agronomy, Punjab Agricultural University, Ludhiana to study the response of groundnut cultivars (bunch and spreading nature) to planting methods and sulphur levels. The experiment was laid in split plot design with three replications comprising five planting methods viz., flat, bed, ridge, trench and furrow sowing with earthing up and two varieties i.e., SG 99 and M 522 in main plots while three sulphur levels viz., S_0, S_{25} and S_{50} in sub plots. The results revealed that maximum seed yield of groundnut (23.78 q/ha) was obtained in furrow sowing followed by earthing up method which was significantly superior over flat and ridge planting and at par with trench and bed planting methods. Similarly, plant height, leaf area index, dry matter accumulation, pods/plant and kernels/pod were more in furrow sowing followed by earthing up planting method. Among varieties, the highest pod yield of 22.42 q/ha was recorded in bunch type variety SG 99 which was statistically at par with the spreading type variety M 522 (22.34 q/ha). The maximum pod yield (23.34 q/ha) was observed with 50 kg S/ha, which was at par with 25 kg S/ha (22.73 q/ha) and significantly higher over control (21.19 q/ha). Haulm yield and total yield were not significantly influenced by various levels of sulphur but both were increased with increase in sulphur levels.

Key Words: Genotype, Oil yield, Planting method, Pod yield, Sulphur.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an economically important oilseed, feed, and food crop widely cultivated in tropical and subtropical regions of the world (Variath and Janila, 2017). It was grown in 53 lakh hectare area and accounted for 91.79 lakh ton production in the country during 2017 (FAOSTAT, 2018). During 1970, it was grown on large area of 174 thousand hectares in Punjab and since then its acreage is decreasing. Large area has been shifted towards rice cultivation. It all has happened on account of evolution of high yielding varieties (HYVs) of rice and development of production and protection technologies. Now the situation has become very precarious on account of the decline in water table and degradation in soil fertility, which has mainly been caused by rice cultivation and all concerns are focused to promote crop diversification. The evolution of HYVs of groundnut may add to the per unit productivity level. Different varieties are suitable for different areas under various environments. Hence, the choice of a suitable variety is very important to get optimum yield and better economical returns. Groundnut varieties differ in their yield potential because of their variable growth habits, inherent genetic potential and partitioning coefficients. In general, the spreading varieties perform better under longer durations and the bunch types tend to yield higher in shorter spans. The crop yield under different planting methods is governed by the light interception, rooting depth, peg penetration and moisture extraction. Groundnut can be planted using a number of methods which include planting on flat ground, bed planting, earthing up after plant in furrow, planting on ridges and trench planting. Earthing up is the raising of the soil around the plant in order to cover the pegs, depending on the

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cultivar (Mhungu and Chiteka, 2010). Moreover, the growth and development of bunch and spreading type cultivars will differ under different planting methods because the physical environment created by the sowing methods will certainly affect the pod formation of different nature of genotypes (bunch and spreading type).

Manan and Sharma (2018) reported that significantly higher pod yield was obtained with application of SSP@ 125 kg/ha and gypsum@ 125kg/ha (19.81 q/ha) followed by use of SSP@ 125kg/ha (18.62 q/ha) and DAP@ 45kg/ha + gypsum@ 125kg/ha (17.94 q/ha), which were statistically at par with each other and concluded that farmers need to apply SSP and gypsum simultaneously, without mixing for getting more number of pods/plant and optimum yield of groundnut. Like other factors of production, sulphur is a secondary nutrient of primary importance essential for the growth of groundnut. It plays an important role in the formation of proteins and is involved in the metabolic and enzymatic processes of all living cells. Sulphur also enhances the nodulation by increasing the supply of sulphur containing proteins which are essential for multiplication and growth of rhizobia. Sulphur also encourage the total biomass production and kernel development of groundnut which is finally reflected on pod yield. So keeping this in view, experiment was carried out to study the response of groundnut genotypes to sulphur application and planting methods.

MATERIALS AND METHODS

Field experiment was conducted at the students research farm, Department of Agronomy, Agrometeorology and Forestry, Punjab Agricultural University, Ludhiana. The experiment was conducted in split plot design with five planting methods viz., flat sowing, bed planting, ridge sowing, trench sowing and furrow with earthing up and two varieties SG 99 (bunch type) and M 522 (spreading type) in main plots and three sulphur levels (0, 25 kg/ha and 50 kg/ha) in sub plots, replicated thrice. The soil of the research site was loamy sand in texture with normal pH and electrical conductivity, low in organic matter (0.28%), available nitrogen (108.0kg/ha) and available sulphur (13.0kg/ha) and medium in available phosphorus (15.8kg/ha) and potassium (186kg/ha) in surface soil layer. Groundnut varieties SG 99 and M 522 were used in this experimental work with seed rate 100 kg and 95 kg per hectare, respectively, treated with Indofil M-45 @ 3gm per kg of kernels. The seeds were sown 4-5 cm deep in flat sowing 30 cm apart with plant-to-plant distance of 15 cm, in bed planted groundnut 18.75 cm apart with plant-to-plant distance 13.5 cm and 19.7 cm, in ridge, trench sowing and earthing-up method 54 cm apart with intra row spacing and 8.4 cm and 12.3 cm for SG 99 and M 522 varieties, respectively. Full dose of the recommended nutrients *viz.,* nitrogen (15 kg/ha), phosphorus (20 kg/ha) and potassium (25 kg/ha) was applied at the time of sowing through urea, SSP and MOP respectively. Weeding was done by two hoeings at 3 and 6 weeks after sowing to remove the weeds. The crop was sprayed with 500g Sevin 50 WP in 250 litres in order to control white grub. The whole dug mass was allowed to dry before plucking the pods. The pods were plucked manually. Biometric observations like plant height, leaf area index and dry matter accumulation were recorded at monthly intervals. Yield and yield attributing characters like biomass weight, pod yield, haulm yield, pods per plant and kernels per pod were recorded.

RESULTS AND DISCUSSION

Plant height

The maximum plant height at 120 DAS was observed under furrow-e method (75.3 cm) followed by bed planting (74.9 cm), ridge sowing (74.3cm), flat planting (72.4 cm) and trench sowing(67.9 cm) (Table 1). This might be due to better moisture availability in furrows which helped in achieving early plant emergence and eventually the plant height (Singh, 2003). The genotype SG 99 produced taller plants than M 522 but the difference was non-significant. The maximum plant height was recorded with 50 kg S/ha but was at par with 25 kg S/ha and control treatments. The increase in growth might be ascribed to better root formation due to sulphur, which in turn activated higher absorption of N, P, K and sulphur from soil and improved metabolic activity inside the plant (Kalaiyarasan *et al*, 2003).

Leaf area index

Highest leaf area index (4.87) was noted under furrow-e method of planting which was significantly higher over flat planting (4.14) and ridge sowing (4.06) but at par with bed planting (4.70) and trench sowing (4.75) methods. Significantly higher values of leaf area index in furrow-e planting method may be due to better moisture availability in furrows, helped in enhancing the emergence and plant height consequently a better vegetative infrastructure and developments. Different genotypes did not influence leaf area index. The variety M 522 had slightly higher leaf area index over SG 99 variety. The sulphur application of 50 kg/ha gave maximum leaf area index which was significantly higher over control and at par with 25 kg S/ha. It was also noticed that the application of 25 kg S/ha and control were at par with each other.

Dry matter accumulation

Amongst the planting methods, higher dry matter accumulation (91.0 q/ha) were recorded in furrow-e method of planting. However, all the treatments were at par with each other. This increase might be due to the better peg penetration favoured by the low values of bulk density and soil strength, more contact area, improved aeration and higher moisture content (Singh 2003). Similarly genotypes also did not differ significantly. Maximum dry matter accumulation (88.60 q/ha) was recorded with 50 kg S/ha at 120 DAS. Overall growth with the application of sulphur in deficient soil could be ascribed to its pivotal role in several physiological and biochemical processes which are of vital importance for development of the plants. Besides, sulphur is involved in the formation of sulphur containing amino acids, vitamins and has direct role in root growth and nodulation.

Pods per plant and number of kernels per pod

The maximum pods per plant (22.87) and kernel per pod (1.49) were recorded under furrow-e that was significantly higher over the flat and ridge planting methods but was at par with bed and trench planting methods. This might be due to an enhanced emergence and establishment owing to higher level of moisture, higher number and weight of pods per plant and dry matter accumulation. These characteristics recorded almost similar values under both genotypes. Application of 50 kg S/ha significantly improved the number of pods per plant (21.90) and kernel per pod (1.40) as compared to control treatment but at par with 25 kg S/ha. 25 kg S/ha and control were also at par with each other. This increase in these attributes might be due to vigorous growth of individual plant as evidenced from increased height and dry matter accumulation. Sulphur also enhanced the nodulation by increasing the supply of sulphur containing proteins, which are essential for multiplication and growth of rhizobia, which are fixing atmospheric nitrogen.

Test weight and shelling percentage

The planting methods had not influenced 100 kernel weight and shelling percentage significantly. The maximum 100 kernel weight (59.67 g) and shelling percentage (62.17 %) was recorded under furrow-e method of planting. The higher kernel weight under furrow-e might be due to covering of stem above the soil surface with earthing up procedure which ease up the process of pegs penetration (Ahmad *et al*, 2015). This increase might be due to low value of bulk density and soil strength, higher number of pods per plant, dry matter accumulation, more contact area, enhanced soil aeration and higher moisture content offered by furrow-e. These characteristics recorded almost similar values under both genotypes. Crop applied with sulphur recorded higher 100 kernel weight and shelling percentage as compared to control. The maximum 100 kernel weight (58.37 g) and shelling

Table. Effect of different planting methods, varieties and sulphur levels on growth and yield of groundnut.

Treatment	Plant height (cm) (120 DAS)	Leaf area index (120 DAS)	Dry matter accumulation (q/ha) (120 DAS)	Pods/ plant	Kernels /pod	100 kernel weight (g)	Shelling (%)	Pod yield (q/ha)	Haulm yield (q/ha)	Biological yield (q/ ha)
Planting method										
Flat	72.4	4.14	85.48	19.81	1.42	55.50	60.61	21.59	65.10	86.69
Bed	74.9	4.70	87.52	22.11	1.46	57.94	62.06	23.33	64.32	87.65
Ridge	74.3	4.06	86.45	18.82	1.43	56.61	60.94	20.80	66.80	87.60
Trench	67.9	4.75	89.42	20.86	1.46	57.56	61.39	22.44	65.92	88.36
Furrow-e	75.3	4.87	91.00	22.87	1.49	59.67	62.17	23.78	67.02	90.8
CD (p=0.05)	NS	0.20	6.85	2.09	0.05	NS	NS	1.54	NS	NS
Variety										
SG 99	73.7	4.47	86.86	20.95	1.47	55.20	60.42	22.42	65.24	87.67
M522	72.2	4.53	89.88	20.84	1.44	59.70	62.44	22.34	66.42	88.77
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sulphur level										
S_0	71.3	4.36	86.82	19.68	1.42	56.13	60.00	21.19	64.65	85.74
S_{25}	72.5	4.53	88.50	21.09	1.46	57.87	61.73	22.73	66.30	89.03
S_{50}	75.1	4.62	88.60	21.90	1.49	58.37	62.57	23.34	66.55	89.89
CD (p=0.05)	NS	0.17	3.57	1.46	0.04	NS	NS	0.78	NS	NS

percentage (62.57%) was recorded under 50 kg S/ha which were higher than control by 2.9 and 4.3 percent, respectively. The increase might be due to vigorous growth of individual plant as evidenced from increased height, branching and leaf area index. This improvement in kernel weight might be due to increased translocation of assimilates towards the seed during active seed filling stages.

Pod yield, haulm yield and biological yield

Furrow-e supported significantly higher pod yield (23.78 q/ha) over flat (21.59 q/ha) and ridge (20.80 q/ha) and at par with trench (22.44 q/ha) and bed planting (23.33 q/ha) methods (Table). The favourable influence of furrow-e in boosting the productivity of pods could be an outcome of the combined effect of several characteristics influenced by it. These included an enhanced emergence and establishment owing to higher level of moisture, higher number and weight of pods per plant and dry matter accumulation. Further, an appropriate development of pods under furrow-e might be due to its effect in creating a congenial physical environment by earthing up at 45 days, loosened the soil at root zone which facilitated the symbiotic nitrogen fixation, aeration, lowering bulk density, soil penetration resistance and facilitate higher rooting density, reduction in ratio of pegs with immature pods to total peg supported by it other than the configurations, which can be attributed to the more favourable soil physical conditions for penetration and pod development and thus positively influencing growth and yield of groundnut. In addition, furrow-e also created a weed free so important for pod development. The covering of stem above the soil surface with earthing up ease the process of pegs penetration. Both the varieties were at par amongst themselves regarding pod yield, haulm yield and biological yield. However, SG 99 variety had shown an edge. Haulm yield and total yield differed non-significantly due to planting methods. However, maximum value of haulm yield (67.02 q/ha) and total yield (90.8 q/ha) were under the furrow with earthing-up configuration. Sulphur application significantly improved the crop productivity estimated in terms of pod yield. Maximum pod yield (23.34 q/ha) was observed with 50 kg S/ha, which was at par with 25 kg S/ha (22.73 q/ha) and significantly higher as compared to control (21.19 q/ha). Haulm yield and total yield was not significantly influenced by sulphur application, while both were increased with the increase in sulphur level. The highest haulm yield (66.55 q/ha) and total yield (89.89 q/ha) were observed with 50 kg S/ha. Improvement in yield might have resulted from favorable influence of sulphur on growth and efficient partitioning and translocation of metabolites to reproductive structures (Rao *et al*, 2013). Sulphur might have encouraged nodulation, total biomass production, kernel development in groundnut which was finally reflected in pod yield. Higher dose of sulphur was responsible for increased leaf area and chlorophyll content of leaves causing higher photosynthesis and assimilation, metabolic activities which were responsible for overall improvement in vigour and yield attributes and finally seed yield. Similar results were also obtained by Upadhyay *et al* (2012) in linseed with sulphur application.

CONCLUSION

It can be concluded that the different planting methods constitute a most vital factor influencing the pod productivity of groundnut planted during summer season. The furrow-e planting method recorded maximum and significantly higher pod yield irrespective of variety over the flat and the ridge planting methods and at par with trench and bed planting methods. Variety SG 99 relatively produced higher pod yield than M 522 but the difference was non-significant. Sulphur application significantly improved the crop productivity. Maximum pod yield was observed with 50 kg S/ha and significantly higher over control.

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