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ENHANCING SESAME OIL CONTENT AND SEED YIELD THROUGH NITROGEN MANAGEMENT

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Abstract

Sesame is an important oilseed crop and receives more attention due to its significance and oil contents. Yield components and quality of oilseed crops are mainly regulated by nutrient management at field level. A field experiment was carried out to assess the effect of nitrogen management on yield and yield component of sesame crop at Agronomy Research farm, The University of Agriculture Peshawar. The experiment was conducted in randomized complete block (RCB) design. Three levels of nitrogen (40, 80 and 120 kg ha^{1}) and four levels of application method (95% soil + 5% foliar, 90% soil + 10% foliar, 85% soil +1 5% foliar) along with one control for both nitrogen levels and one water spray for application method were used in experiment. Urea was applied as sources of nitrogen. The application of nitrogen at the rate of 120 kg ha^{-1} resulted in maximum biological yield (4002 kg ha^{-1}). With respect to 80 kg N ha^{-1} application resulted more capsule plant^{1} (82), seed capsule^{1} (61), more seed yield (839 kg ha^{1}), oil % (46.85 %), and oil yield (394 kg ha^{1}). Similarly nitrogen application method at 90% soil + 10% foliar produced more seed capsule^{1} (60), seed yield (858 kg ha^{-1}), more oil % (47.39% kg ha^{-1}) and maximum oil yield (407 kg ha^{-1}) were recorded. From the experimental results, it is concluded that nitrogen application at the rate of 80 kg ha^{-1} at 90% soil + 10% foliar application method performed better in terms of oil content, oil and seed yield of sesame and is recommended for general cultivation of sesame.

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Introduction

Sesame (*Sesamum indicium* L.) is oil seed crop belongs to family pedaliaceae. It is an annual minor kharif oilseed crop. It has broadleaf, self-pollinated and short-day crop, normally flowering in 43-46 days. The plant has indeterminate growth habit, and therefore the capsule do not mature uniformly. Sesame grown in tropical zones as well as intemperate zones. Sesame produces high-quality of edible oil which is used for cooking and salad. Sesame is known as the king of oil seed crop because of its more oil percentage (Toan*et al.*, 2010). Sesame oil is colorless and odorless. The seed of sesame plant oil contain (46-64%), protein (20-28%) sugar (14-16%), and minerals (5-7%) (Thanvanathan *et al.*, 2001).

Nitrogen is important because it is major component of chlorophyll. Nitrogen is the major component of the amino acid, building block of protein (Shilpi *et al.*, 2012). Nitrogen help growth and development of plant. Enhancing productivity need various factor keep optimum sowing date. Proper nitrogen level, sulfur, phosphorus, and improved sesame varieties play important role. Sesame is cultivated for many centuries, especially in the developing countries of Asia and Africa. Applying a balanced commercial fertilizer is planting time is required satisfactory production on soil of low to moderated fertilizer. The application of fertilization to the sesame crop either in inorganic or organic form, is key component high seed quality seed, good growth, high yield, oil and protein content and also economic return. Growth parameter such as number of branches per plant, plant height, leaf area index and dry mater portitioning significantly increases with increase fertilizer (Gnanamurthy *et al.*, 1992).

Nitrogen is an essential element for sesame growth to build up protoplasm and protein which induce cell division, meristematic activity and further increased cell number and size with an overall increase in sesame growth and seed production (Shilpi *et al.*, 2012). The application of NP fertilizer had influence the oil content significantly maximum at 25-25 kg ha^1 (Sharer *et al.,* 2000). When NP level increase 50-50 kg ha^1 the oil content decrease significantly. The nitrogen fertilizer influence all the yield parameters except number seed per pod (Shehu *et al.*, 2010). Foliar application of nitrogen significantly increase plant height, spike length, number of grain $spike^1$, thousand grain weight, and grain yield (Saeed *et al.*, 2012). Foliar fertilizer in recent times is receiving considerable attention for increasing crop yield (Satyanarayanamma *et al.*, 1996). The yield and growth parameter were much affect by the mood of application, concentration of nutrients and fertilizer doses. Foliar + soil application give maximum value in term of growth (El- Defan *et al.*, 1999). The growth and yield of plant increase when fertilizer applies through soil or through foliar and soil together. Treatment through foliar and soil together yield better result. Keeping in view the above constraints this research was carried out the most suitable nitrogen level and soil application methods for sesame cultivar for higher production in agro climatic condition of Peshawar Pakistan.

Materials and methods

The experiment entitled was conducted at Agronomy Research Farm of The University of Agriculture, Peshawar Pakistan. The experiment was carried out in randomized complete block (RCB) design with three replications. Three levels of nitrogen (40, 80 and 120 kg ha^{-1}) and four levels of nitrogen application methods (M1= Soil application, M 2 =95% soil +5% foliar, M 3 = 90% soil +10% foliar, M 4 = 85% soil +15 foliar were used in the experiment. In addition to the above, one control treatment (N= 0 and M= 0) and one water spray treatment was maintained in each replication. Foliar spray wascompleted in two days in two equal splits before flowering stage. For application of N through foliar spray, 5%, 10% and 15% solution of Urea was prepared. Keeping in view the treatments and volume to wet the plot area completely, the solution was further diluted with water. Plot size of 3m x 3.6m, having 6 rows with row to row distance of 60cmand plant to plant distance of 10cm was maintained. Half of the soil nitrogen in the form of Urea was applied at the time of sowing and half was applied with first irrigation. Local black variety was sown at the rate of 5 kg ha $^{-1}$. Data were recorded on capsule plant^{-1}, seeds capsule^{-1}, biological yield (kg ha^{-1}), seed yield (kg ha^{-1}), oil yield (kg ha^{-1}) and oil content (%). All other agronomic practices was carried out uniformly for all the experimental units.

Data collection

Number of capsules plant^{-1}

From the each experimental unit five randomly selected plants were taken and counted capsules in each p1ant and then averaged.

Number of seeds capsule^{-1}

In each experimental unit five capsules were selected of various sizes and counted seed in each capsule and averaged.

Biological yield (kg ha^{-1})

At maturity stage four central rows were harvested in each experimental unit allowed to dry to constant weight, and weighed with the he1p of spring ba1ance then converted to kg ha^{-1}.

Seed yield (kg ha^{-1})

Four centra1 rows harvested in each experimenta1 unit, the harvested rows threshed, dried, weighed and converted in kg ha^{-1} for the seed yie1d of sesame crop.

Oil content (%)

Through Soxhelt equipment and petroleum ether determine the oil content at Nuc1ear Institute for Food and Agricu1ture (NIFA) Peshawar. To find out oil content taken weight round bottom flask (W1) then filled the flask with 1/3 petroleum ether. The seeds were cover in filter paper and placed petroleum ether at 45-60°C about an hour. Due condensation water was flowed and this process continues the ether evaporated until the oil settled down in the flask. After oil settled down the flask was kept in desiccator for 30 minutes and was recorded the weighed (W2). The obtained data then analyse oil (%) for every seed sample.

Oil yield (kg ha^{-1})

Data concerning oil content (%) that was determined for each sample with, oil content multiplied seed yield kg ha^{-1} and divided by 100 and obtained oil yield kg ha^{-1} basis.

Statistical Analysis

The data was ana1yzed by using appropriate techniques for ana1ysis of variance for the randomized complete block design using software statistics 8.1 made suitable for statistical analysis and LSD test at level of 0.05% probability (Steel and Torrie, 1984).

Results and discussion

Capsule plant^{-1}

Data related to capsule plant^{-1} of sesame as affected by nitrogen levels and application methods (Table 1).

Table 1. Represents capsule plant^{-1}, seeds capsule^{-1} and biological yield (kg ha^{-1}) as influenced by nitrogen levels and its application methods.

Nitrogen methods	Capsule plant^{-1}	Seeds capsule^{-1}	Biological yield (kg ha^{-1})
Soil Application	62 c	45 c	3753 c
95% Soil + 5% Foliar	64 c	47 b	3851 b
90% Soil + 10% Folair	72 a	50 a	4042 a
85% Soil + 15% Folair	68 b	47 b	3940 b
LSD (P ≤ 0.05)	3.70	1.84	91
Nitrogen levels			
40	59 c	45 c	3788 c
80	73 a	50 a	3900 b
120	67 b	48 b	4002 a
LSD (P ≤ 0.05)	3.20	1.59	79
Water spray	57	43	3226
Rest	66	47	3896
Control	55	41	4149
Rest	66	47	3845

Likewise control vs rest was found significant, whereas the interaction of nitrogen and application method (N × AM) was found non-significant for capsule plant^{-1} of sesame. Mean value of the data observed that increase in capsule plant^{-1} of sesame with increasing nitrogen levels from (40 to 80 kg ha^{-1}) while further increase beyond 80 kg ha^{-1} nitrogen didn't show any significant increase in capsule plant^{-1}. Higher capsule plant^{-1} (82) of sesame were revealed with application of 80 kg ha^{-1} nitrogen while less capsule plant^{-1} (69) were recorded with 40 kg N ha^{-1}.Less number of capsules plant^{-1} was observed at the rate of 40 kg N ha^{-1}. Ibrahim *et al.* (2014) and Khan *et al.* (2016) concluded the slimier result and said that increase in number of capsule plant^{-1} due to uptake of active nutrient and good development of crop due to high dose of nitrogen. With respect to application methods, increasing foliar spray from 5% to 15% more capsule plant^{-1}(82) were observed with application of 85% soil + 15% foliar application. While less capsule plant^{-1} (72) were recorded full level of soil application.

Treated plots capsule plant^{-1}(79) in comparison to control plots (63), similarly, rest more capsule plant^{-1} (77) while water treated plots less branches plant^{-1} (67). The results are in conformity with the Malik *et al.* (2003) who observed that increase in nitrogen had produced more capsule plant^{1}.

Table 2. Represents seed yield (kg ha^{-1}), oil yield (kg ha^{-1}), and oil content (%) as influenced by nitrogen levels and its application methods.

Nitrogen methods	Seed Yield (kg ha^{-1})	Oil Yield (kg ha^{-1})	Oil content (%)
Soil Application	722 c	308 d	42.22 c
95% Soil + 5% Foliar	771 b	336 c	43.28 bc
90% Soil + 10% Folair	943 a	441 a	46.72 a
85% Soil + 15% Folair	928 a	405 b	44.72 ab
LSD (P ≤ 0.05)	29	23	23.25
Nitrogen levels			
40	748 c	308 c	41.07 c
80	911 a	424 a	46.85 a
120	864 b	385 b	44.79 b
LSD (P ≤ 0.05)	25	20	30.12
Water spray	551	228	41.33
Rest	848	373	44.90
Control	514	204	39.67
Rest	819	361	44.63

Seeds capsule^{-1}

Table 1 showed data regarding seeds capsule^{-1}of sesame as influenced by different nitrogen levels and application methods. Analysis of data exhibits that nitrogen and application methods significantly affected number of seeds capsule^{-1} of sesame. While their interaction (N × AM) was significant. Likewise control vs rest and water spray vs rest as also found significant for seeds capsule^{-1} of sesame. Mean values of the data exhibit increase seeds capsule^{-1} of sesame with increasing the application of nitrogen levels from 0 to 80 kg ha^{-1}, while further increase in nitrogen level didn't show any significant increase in seeds capsule^{-1} of sesame. Application of 80 kg ha^{-1} nitrogen produced higher seeds capsule^{-1} (61) of sesame. While lower seeds capsule^{-1} (55) recorded with 40 kg ha^{-1} nitrogen. Due to this high nitrogen capability and more sunlight capture as a result more integrate goes towards reproductive parts and finally more number of seeds capsule^{-1}. Our results are in line with Tiwari *et al.* (2000).Regarding application method increasing foliar spray from 0 to 10% higher (60) seed ccapsule^{-1} were recorded with application of 90% soil + 10% foliar spary, whereas less seeds capsule^{-1} (56) were absorbed full level of soil application. Fertilizer plots more seeds capsule^{-1}(57) in comparison to control plots (45) in addition, rest seeds capsule^{-1} (58) while water treated plots less capsule length (49).

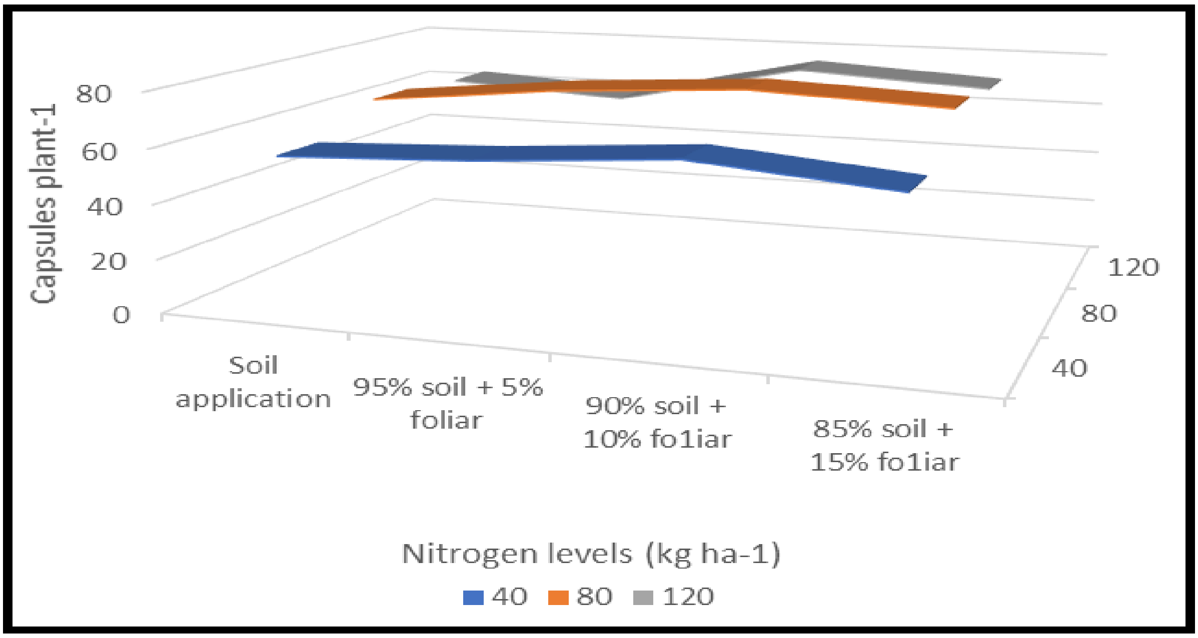

Fig. 1. Shows capsule plant^{-1} of sesame as influenced with nitrogen management.

The possible reason may be number of grain could be due to availability of sufficient nitrogen to all part of plant due to easily availability of nitrogen to via leaves absorption.

These results are in lines with El-Said *et al.* (2016) they reported that nitrogen is the building block of photosynthesis of sesame plant therefore might have results satisfactory capsule growth and more number of seeds.

Biological yield (kg ha^{-1})

Data related to Biological yield of sesame as affected by different nitrogen levels and application methods are reported in Table 1. Control vs rest and water spary vs rest was significant. Their interaction of nitrogen and application method (N × AM) was found non-significant biological yield of sesame. Mean value of data related biological yield exhibited increase in biological yield of same with increasing nitrogen from (0 to 120 kg ha^{-1}). Maximum biological yield (4002 kg ha^{-1}) of sesame was recorded from 120 kg N ha^{-1} while lower biological yield (3788 kg ha^{-1}) was produced by applying 40 kg N ha^{-1}.As nitrogen increases vegetative parameters such as plant height, leaf area etc. which ultimately increases biological yield. Our result is supported by Shehu *et al.* (2010) reported increase in biological yield with increment in N application rates.

With respect to application methods, biological yield was maximum (4042 kg ha^{-1}) with 90 % soil + 10 % foliar applied nitrogen, while minimum (3754 kg ha^{-1}) biological yield was harvested from 100 % N applied in soil. More biological yield (3845 kg ha^{-1}) was recorded in rest plots than control (3149 kg ha^{-1}). Likewise, treated plots resulted in maximum biological yield (3896 kg ha^{-1}) than water sprayed plots (3221 kg ha^{-1}).

This increase in biological yield could be due to their important role in crop growth, photosynthesis and assimilate accumulation. Our results are in line withZeidan*et al.* (2010), reported increase in biological yield with foliar application of nitrogen.

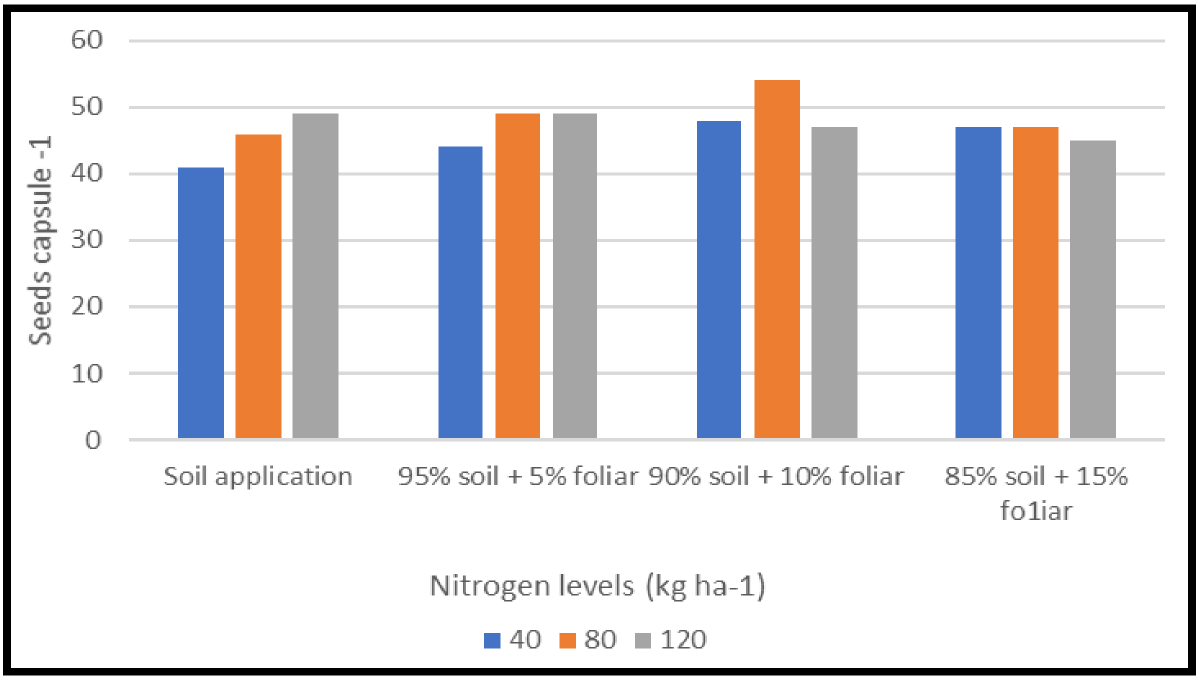

Fig. 2. Shows seeds capsul^{-1} of sesame as influenced with nitrogen management.

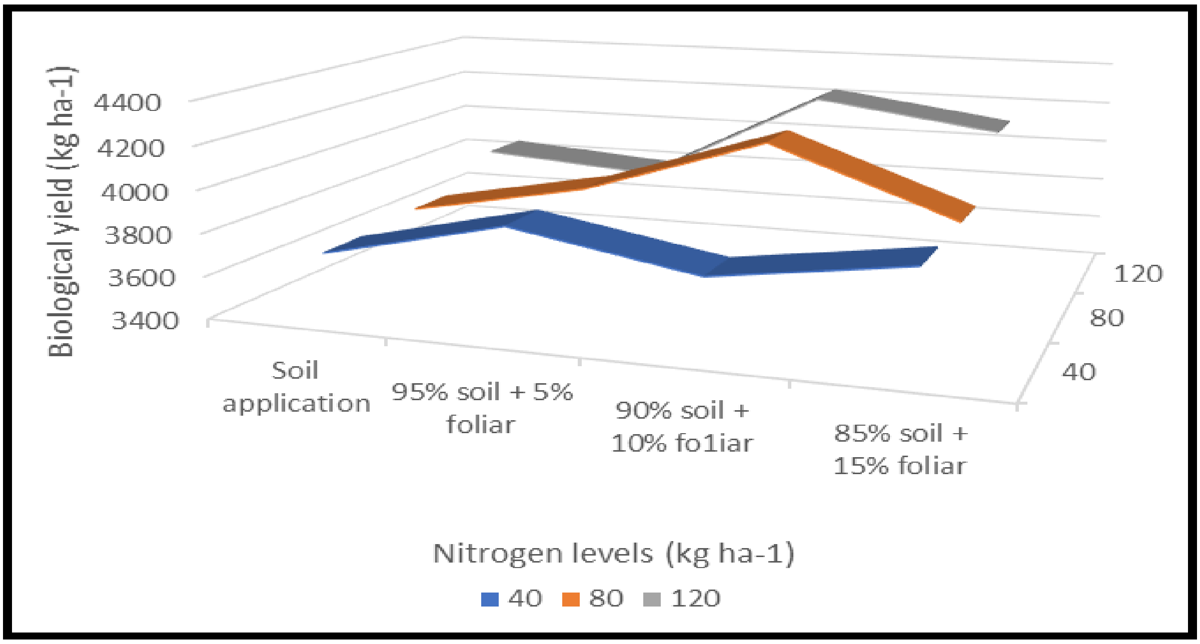

Fig. 3. Shows seeds biological yield (kg ha^{-1}) of sesame as influenced with nitrogen management.

Seed yield (kg ha^{-1})

Table 2 showed that seed yield of sesame as affected by nitrogen levels and application methods. Analysis of data indicated that nitrogen levels and application methods significantly the seed yield of sesame. As well, control vs as rest and water spray vs rest was also significant. Their interaction (N × AM) was found significant for yield sesame. Mean values of data indicated that increase in seed yield with increasing nitrogen from (0-80 kg ha^{-1}), while further increase above 80kg ha^{-1} nitrogen application did not show any increase in seed yield of sesame. Higher seed yield (839 kg ha^{-1}) of sesame were obtained from 80 kgha^{-1} nitrogen, while lower seed yield (748 kg ha^{-1}) were observed 40 kg ha^{-1} nitrogen application.This could be due the positive effect of N on growth and yield attribute of sesame which boost the final seed yield, however further increase in N application cause lodging which reduce the seed yield. Our findings are in conformity with Ali and Ahmed (2012) they reported that seed yield increases with increasing N. With respect to application method, seed yield was higher (858kg ha^{-1}) with 90% soil + 10% foliar application. While lower (744kg ha^{-1}) seed yield was harvested from 100% N applied in soil.More seed yield (784 kg ha^{-1}) was recorded in fertilized plots than control (514 kg ha^{-1}). Likewise, treated plots resulted in maximum seed yield (804 kg ha^{-1}) than water-sprayed plots (551 kg ha^{-1}). This might be due to the efficient uptake and utilization of N by sesame crop through foliage and under-ground root portion.

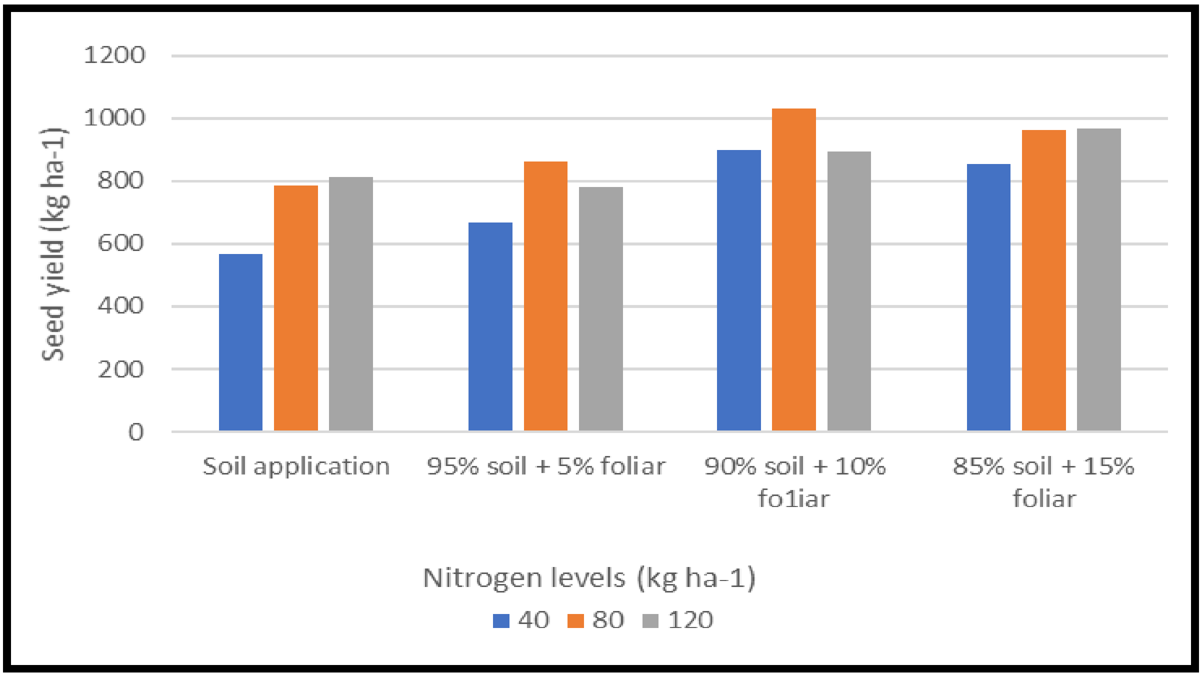

Fig. 4. Shows seeds seed yield (kg ha^{-1}) of sesame as influenced with nitrogen management.

Oil yield (kg ha^{-1})

Data related to oil yield of sesame as influenced by different nitrogen rates and application methods are presented in (Table 2). Statistically analysis of data showed that nitrogen rates and application methods significantly varied the oil yield of sesame. Similarly control vs rest was found significant, while their interaction was found non-significant. Mean value of data related oil yield showed increase oil yield of sesame with increasing nitrogen from 0-80 kg N ha^{-1}, while further increase did not show any significant increase in oil yield. Maximum oil yield (394 kg ha^{-1}) of sesame was observed with application of 80 kg ha^{-1} nitrogen, while minimum oil yield (316kg ha^{-1}) was recorded with 40 kg N ha^{-1}.This increase in oil yield might be due to increase in seed and oil content of sesame with 80 kg ha^{-1} of N application. Similar, findings were quoted by Yasir *et al.* (2013) who recorded maximum oil yield with higher level of nitrogen. With respect to application methods, maximum oil yield (407 kg ha^{-1}) were noted with 90% soil + 10% foliar spray, however minimum oil yield (321 kg ha^{-1}) was recorded with full soil application. Treated plots, in comparison with control produced more oil yield (352 kg ha^{-1}), similarly fertilized plots produced more oil yield (363 kg ha^{-1}) then water spray plots. The probable reason might be that there was moderate rate of both soil and foliar application of nitrogen. Our results agree with Menorak and Quins (2009) who also explained same results like our in his findings.

Oil content (%)

Table 2 showed data related to oil percentage of sesame as affected by nitrogen levels and application methods. Control vs rest was found significant, while their interaction was found non-significant for oil percentage of sesame (Fig. 6).

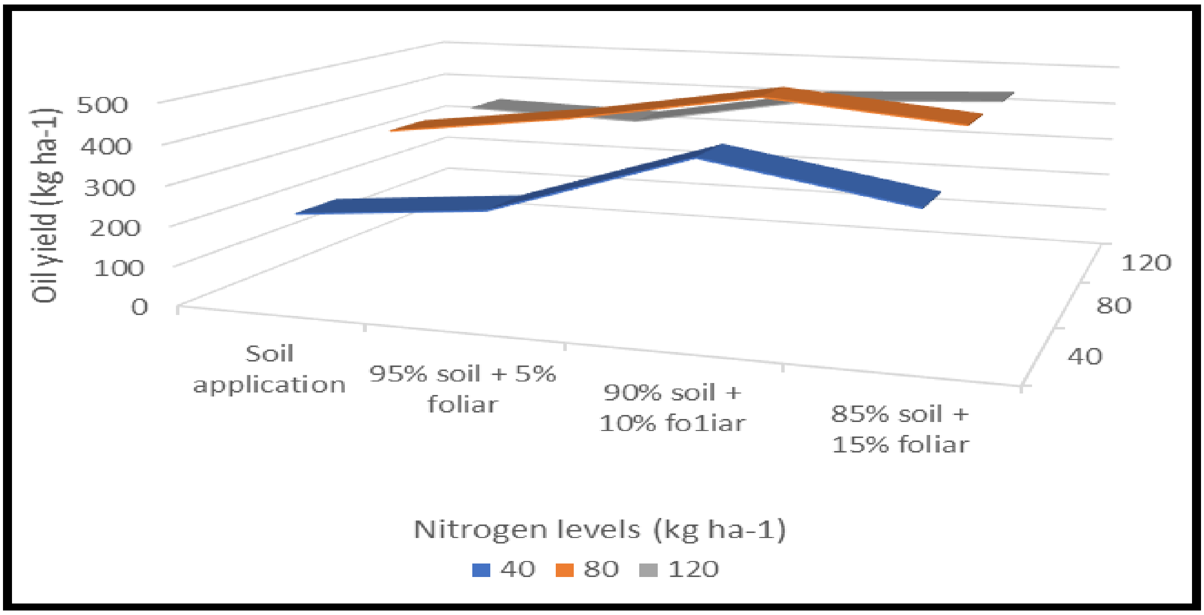

Fig. 5. Shows seeds oil yield (kg ha^{-1}) of sesame as influenced with nitrogen management.

Mean value of data related oil percentage showed increase oil percentage of sesame with increasing nitrogen from 0-80 kg N ha^{-1}, while further increase did not show any significant increase in oil percentage. Higher oil percentage (46.85 %) of sesame was observed with application of 80 kg ha^{-1} nitrogen, while lower oil percentage (42.07 %) was recorded with 40 kg N ha^{-1}. Oil content was maximum at nitrogen level of 80 kg ha^{-1}, while minimum oil content was recorded in control plot. Increment in N application increase protein content, while reduce oil content due to negative correlation in oil and protein content.

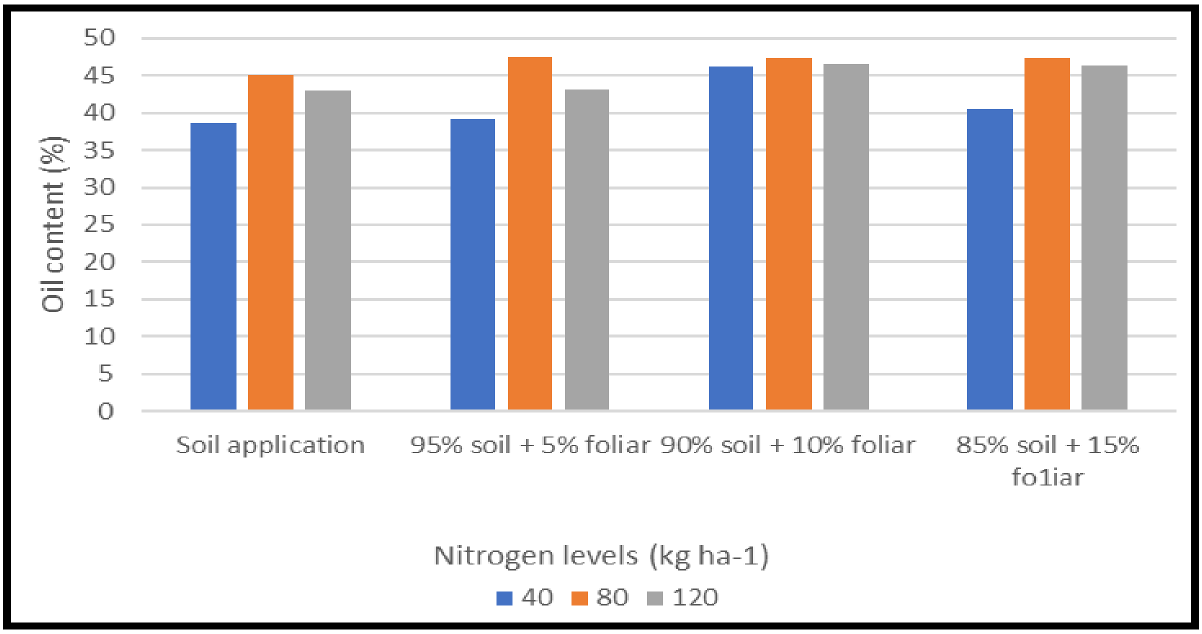

Fig. 6. Shows oil content (%) of sesame as influenced with nitrogen management.

Matching results were earlier reported by Fayed *et al.* (2000) found that oil content increased with a slight increase of N. With respect to application methods, maximum oil percentage (47.39 %) were noted with 90% soil + 10% foliar spray, however minimum oil percentage (42.89 %) was recorded with full soil application. Treated plots, in comparison with control produced more oil percentage (44.63 %), similarly fertilized plots produced more oil parentage (44.90 %) then water spray plots.

This might be due to the reason that applying 10 % N as foliar enhanced crop growth and quality which ultimately increase the oil content. These results are in agreement with Hinton*et al.* (2012), stated that increasing foliar percentage decreased oil content in sesame crop.

Conclusion

It is concluded from the experimental findings that application of 80 kg ha^{-1} nitrogen with nitrogen application method of 90% soil + 10% foliar performed better in response to yield and yield components, oil yield and oil content (%) of sesame as compared to other levels and thus, it is recommended for general cultivation of sesame crop under the agroclimatic condition of Peshawar Pakistan.

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