Research Article

Influence of sowing time and nitrogen fertilization on *Alternaria* leaf blight and oil yield of Sesame cultivars

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Abstract

Two sesame cultivars (*Sesamum indicum* L.) were evaluated using various 3 different sowing dates (20th June, 10th and 30th July) and four nitrogen levels (0, 40, 80 and 120 kg N ha⁻¹) at the New Developmental Farm of The University of Agriculture, Peshawar, Pakistan during summer 2012. The experiment was laid out in randomized complete block design (RCBD) with split plot arrangement using four replications each. Sowing dates and sesame cultivars (local black and local white) were allotted to the main plots, while nitrogen levels were allotted to sub-plots. Results exhibited that plants sown on 20th June had significantly higher oil yield (522 kg ha⁻¹), seed yield (1135 kg ha⁻¹) and nitrogen use efficiency (15%) while 10th July sowing showed higher *Alternaria* leaf blight incidence (77%) and severity (45%) as compared with other sowing dates. Local black cultivar had significantly more oil content (47%), oil yield (335 kg ha⁻¹), seed yield (696 kg ha⁻¹) and Nitrogen Use Efficiency (NUE) (12%) as compared with local white cultivar which showed higher *Alternaria* leaf blight incidence (46%) and severity (28%). Plots treated with 120 kg N ha⁻¹ produced maximum *Alternaria* leaf blight incidence (49%), disease severity (31%), oil content (52%), oil yield (433 kg ha⁻¹) and seed yield (833 kg ha⁻¹) but higher NUE (15%) was obtained when plots were treated with 40 kg N ha⁻¹. The interaction among sowing dates, cultivars and nitrogen level revealed that sesame cultivar local black sown on 20th June and supplied nitrogen @ of 120 kg ha⁻¹ had produced higher oil content, oil yield and seed yield but NUE was significantly higher when plots were treated with 40 kg N ha⁻¹. Local black cultivar sown on 20th June and treated with 120 kg N ha⁻¹ produced the best results in terms of oil content, oil yield, seed yield and minimum *Alternaria* leaf blight disease incidence and severity percentage.

Key words: *Alternaria* leaf blight, nitrogen level, Oil content, Sesame (*Sesamum indicum* L.)

1. Introduction

Sesame (*Sesamum indicum* L.) belongs to family Pedaliaceae. It is an annual, self-pollinated and indeterminate minor summer oilseed crop in Pakistan. Capsules mature from bottom to top, allowing shattering of the lower ones by the time the uppermost capsules get matured. It is a short-day plant, normally flowering in 42-45 days. Sesame seeds are small and ovate with two distinct types, cream-colored and black. Cream-colored seed are preferred due to sweeter taste [1]. The crop has high quality of edible oil (42-54%) and protein contents (22 to 25%). Its oil has high degree of stability and

resistance to rancidity [2]. It is colorless and has a longer shelf life, which is used for cooking, medicinal, and as salad oil [1]. In Pakistan, sesame was cultivated on an area of 77.6 thousand hectares with an annual production of 31 thousand tones and an average yield of 401 kg ha⁻¹. Whereas in Khyber Pakhtunkhwa (KPK) province, its average yield was 1000 kg ha⁻¹ [3].

Sesame is not a major crop in Pakistan but due to chronic shortage of edible oil in the country, serious efforts are underway to increase its production. Sesame yield is highly variable depending upon the growing environment, cultural practices and cultivars

[4]. However, there are studies where plant height and dry matter of sesame has increased significantly with an increase in nitrogen up to 150 kg ha⁻¹ [5]. Seed oil content was also increased by N application except at the highest rate (120 kg N ha⁻¹) which slightly reduced oil content compared with the control [6]. One major problem of the sesame production in Pakistan is the leaf blight disease, which sometimes occur in epidemic form. Leaf blight of sesame caused by *Alternaria sesami*, is seed-borne in nature. The disease is favored by prolonged wet and humid conditions [7]. The leaf spots cause a decline in photosynthetic area that is usually followed by pre-mature defoliation resulting in poor growth and yield [4]. The fungus kills seedlings and young plants causing yield losses up to 59% [8]. The disease can be effectively controlled by the use of disease-free seeds [9], and cultivation of resistant varieties, which is the most effective, environment-friendly and cheap method of disease control as compared to the use of chemicals. Adequate nutrition and cultural practices such as sowing dates can also be helpful in terms of disease control [10]. Yield decreases progressively with the delay in planting from optimum time of sowing [11]. Keeping in view the above facts, this experiment was mainly conducted to find out the optimum sowing date, nitrogen level and cultivar for higher yield and *Alternaria* leaf blight control in the agro-climatic condition of Peshawar.

2. Materials and Methods

2.1 Experimental site, design and agronomic management

The experiment was conducted at the New Developmental Farm of the University of Agriculture, Peshawar (34° 00' N, 71° 30' E, 359 meters above sea level) Pakistan during summer 2012. The experiment was carried out in randomized complete block design (RCBD) with split plot arrangement having four replications each. Sowing dates and sesame cultivars were allotted to main plots, while nitrogen levels to the sub plots. A subplot size of 2.4 x 3 m was used. Each sub-plot was consisted of 6 rows having 40 cm row-to-row distance. Phosphorus was applied at the rate of 60 kg ha⁻¹ whereas half of nitrogen was applied at the time of sowing and half was applied before flowering. Seeds were sown at rate of 4 kg ha⁻¹ and other agronomic practices like weeding and irrigation were carried out uniformly for all the experimental units throughout the growing season.

2.2 Observations

To record disease data, total number of plants and number of infected plants in one m⁻² were counted and the percentage of disease incidence was also worked out. Disease severity was measured by counting the number of lesions and rating the

symptom expression on 0 to 6 scales (Table 1). The Temperature, rainfall and relative humidity of experimental site for the growing period of the sesame crop (June-October 2012) is shown in Table 2

$$\text{Disease incidence (\%)} = \frac{\text{Number of diseased plant m}^{-2} \times 100}{\text{Total number of plant m}^{-2}}$$

$$\text{Disease severity (\%)} = \frac{\text{Sum of individual numerical rating} \times 100}{\text{Total number of assessed} \times \text{Total number of plant m}^{-2}}$$

Seed oil content (%) was determined by using Soxhlet apparatus and n-hexane (60°C) as an extraction solvent according to [12]. Seed yield was taken with an electronic balance after threshing the capsules. Data were taken for seed yield in four central rows in each subplot and then converted into kg ha⁻¹. Oil yield was calculated by following formula.

$$\text{Oil yield (kg ha}^{-1}\text{)} = \frac{\text{Seed oil content (\%)} \times \text{seed yield (kg ha}^{-1}\text{)}}{100}$$

Nitrogen use efficiency (NUE) was calculated as [13]:

$$\text{NUE} = \frac{\text{Seed yield (kg ha}^{-1}\text{)}}{\text{Nitrogen applied (kg ha}^{-1}\text{)}}$$

2.3 Statistics

Data collected were analyzed statistically according to the procedure relevant to the randomized complete block design (RCBD). Upon significant F-Test, least significance difference (LSD) test was used for mean comparison to identify the significant components of the treatment means [14].

3. Results and Discussion

3.1 *Alternaria* leaf blight incidence and severity (%)

Data on *Alternaria* leaf blight incidence and severity are presented in Table 3. Mean values of the data showed that crop sown on 10th July produced maximum disease incidence (77%) and severity (45%) while minimum disease incidence (15%) and severity (6%) were observed when crop was sown on 20th June. The reason could be that early July sown crop received more rains making the weather wet and humid. Such conditions kept leaf surface humid which favored leaf infection [15]. With an increase in nitrogen level, significant increase in disease incidence and severity was recorded. Plots treated with 120 kg N ha⁻¹ produced higher disease incidence (49%) and severity (31%) while minimum disease incidence (34%) and severity (18%) was observed in control plots. The disease incidence and severity increased with increasing levels of nitrogenous fertilizer. Abundant availability of N resulted in succulent growth, which is usually more susceptible to disease. Local white cultivar produced higher disease incidence (46%) and severity (28%) as compared with local black cultivar which showed 37% disease incidence and 20% disease severity.

Table-1. Disease scores for *Alternaria* leaf blight disease of sesame

Scale	Rating	<i>Alternaria</i> leaf spot characteristics
0	No disease	No trace of infection
1	Hypersensitivity	Hypersensitivity spot on lower leaves only
2	Trace infection	Small lesions on lower leaves only
3	Slight infection	Small lesions on lower and upper leaves and stem
4	Moderate infection	Advanced lesions on upper and lower leaves, with or without new infections on stem and petiole
5	Severe infection	Advanced lesions on upper and lower leaves, flower, buds, stems and petiole and slight infection of pod
6	Very severe infection	All features of 5 above with severe infection of pod

Table-2. Temperature ($^{\circ}\text{C}$), rainfall (mm) and relative humidity (%) experimental site for the growing period of the sesame crop (June-October 2012)

Month	Mean temperature ($^{\circ}\text{C}$)		Mean rainfall (mm)	R.H (%)
	Minimum	Maximum		
June	22	43	0	35
July	27	41	80	56
August	26	38	100	59
September	23	35	0	70
October	15	31	56	56

Table-3. *Alternaria* leaf blight incidence (%) and severity (%), oil content (%), oil yield (kg ha^{-1}), seed yield (kg ha^{-1}) and nitrogen use efficiency (NUE) of sesame cultivars as affected by sowing dates and nitrogen levels

Treatment	<i>Alternaria</i> leaf blight incidence (%)	<i>Alternaria</i> leaf blight severity (%)	Oil content (%)	Oil yield (kg ha^{-1})	Seed yield (kg ha^{-1})	NUE
Sowing dates						
20 th June	15 c	6 c	46	522 a	1135 a	19 a
10 th July	77 a	45 a	45	195 b	433 b	7 b
30 th July	34 b	22 b	45	138 c	306 c	5 c
LSD (0.05)	8.86	6.86	Ns	27.89	56.68	0.87
Sesame cultivars						
Local White	46 a	28 a	45 b	249 b	554 b	9 b
Local Black	37 b	20 b	47 a	335 a	696 a	12 a
Nitrogen(kg ha^{-1})						
0	34 d	18 d	40 d	136 d	339 d	-
40	39 c	23 c	44 c	268 c	609 c	15 a
80	45 b	27 b	48 b	345 b	718 b	9 b
120	49 a	31 a	52 a	433 a	833 a	7 c
LSD (0.05)	1.90	1.77	0.06	12.48	24.35	0.17
Interaction						
D x V	ns	ns	ns	ns	Ns	ns
D x N	*	*	ns	ns	Ns	ns
N x V	ns	ns	Ns	ns	Ns	ns
D x V x N	ns	ns	*	*	*	*

Means in the same category followed by different letters are significantly different from each other at $P \leq 0.05$ levels. ns = non-significant

Fig.1. Alternaria leaf blight incidence (%) as affected by sowing dates and N levels

Fig.2. Alternaria leaf blight severity (%) as affected by sowing dates and N levels

Fig.3. Oil content (%) as affected by sowing dates, cultivar and N levels

Fig.4. Oil yield (kg ha⁻¹) as affected by sowing dates, cultivar and N levels

Fig.5. Seed yield (kg ha⁻¹) as affected by sowing dates and N levels

Fig.6. NUE as affected by sowing dates, cultivars and N levels

Resistant varieties have been found to enhance levels of plant defense secondary metabolites such as phytoalexins [5]. Interaction between sowing dates x nitrogen showed (Fig.1 & 2) that the crop planted on 10th July had a very good response to nitrogen application and therefore more susceptible to disease incidence (88%) and disease severity (57%) respectively as compared with control plots and other sowing dates.

3.2 Seed oil content (%)

Analysis of data given in Table 3 revealed that sesame cultivars and nitrogen levels had significantly affected oil content while sowing dates had no significant effect on oil content. Plots treated with 120 kg N ha⁻¹ produced higher oil content (52%) while smaller oil content (40%) was recorded in control plots. Similar results were reported by other researchers [16, 17]. They reported that increase in seed oil content by increasing nitrogen fertilizer rate might be due to the role of nitrogen in transforming metabolic products to amino acids and fatty acids. Local black cultivar recorded higher oil content (47%) as compared to local white cultivar (45%). Interaction among sowing date x cultivar x nitrogen indicated that oil content of both cultivars sown on 20th June increased with an increase in nitrogen levels (Fig. 3). However, when the sowing was delayed to 30th July, the response of nitrogen application was as effective as seen on 20th June. The oil content (%) remains almost similar in all sowing dates.

3.3 Oil yield (kg ha⁻¹)

Data presented in Table 3 showed that oil yield was significantly reduced with delay in sowing. Plots sown on 20th June had significantly higher oil yield (544 kg ha⁻¹) while lower oil yield (143 kg ha⁻¹) was recorded for 30th July sowing. These results are in line with earlier reports [11, 18] who reported that higher oil yield was obtained from the early (June) sowing as compared to the late sowing. The higher seed yield obtained from the early sowing was mainly due to the production of higher number of branches and capsules plant⁻¹ as a result of which oil yield also increased with an increase in seed yield. Plots supplied with nitrogen had significantly higher oil yield as compared to control plots. With increase in nitrogen level, oil yield increased significantly and the higher level of nitrogen (120 kg ha⁻¹) produced higher oil yield (435 kg ha⁻¹) while lower yield was recorded in control plot (136 kg ha⁻¹). These results confirm the findings of previous publication [13, 19] who reported that increasing rate of nitrogen up to 120 kg ha⁻¹ linearly enhanced the oil yield. Local black cultivar recorded higher (335 kg ha⁻¹) oil yield as compared to local white cultivar which produced 257 kg ha⁻¹ oil. Interaction of sowing date x cultivar x

nitrogen given in (Fig. 4) showed that both cultivars produced higher oil yield when sown on 20th June.

3.4 Seed yield (kg ha⁻¹)

Mean value showed that seed yield significantly reduced with delay in sowing (Table 3). Plots sown on 20th June had significantly higher seed yield (1135 kg ha⁻¹) while lower seed yield (306 kg ha⁻¹) was recorded for 30th July sowing crop. These results are in line with earlier reports [11, 18] who reported that higher seed yields were obtained from the 20th June sown crop as compared to the late sowing. The higher seed yield obtained from the early sowing was mainly due to the production of higher number of branches and capsules plant⁻¹. Plots supplied with nitrogen had significantly higher seed yield as compared to control plots. With increase in nitrogen level, seed yield also increased significantly and the highest level of nitrogen (120 kg ha⁻¹) produced maximum seed yield (833 kg ha⁻¹). These results are in agreement with the findings of [13] and [19] who reported that increasing rate of nitrogen application linearly enhanced seed yield. Local black cultivar recorded higher (696 kg ha⁻¹) seed yield as compared to local white cultivar (554 kg ha⁻¹). Interaction of sowing date x cultivar x nitrogen revealed in (Fig. 5) that both cultivars produced higher seed yield when sown on 20th June. Seed yield increased with an increase nitrogen levels, however, early sown crop had higher seed yield even when nitrogen was not added as compared with other sowing dates. Similar findings were also obtained for soybean and pea cultivars, respectively [20, 21].

3.5 Nitrogen Use Efficiency (NUE)

NUE significantly decreased with delay in sowing (Table 3). Plots sown on 20th June showed higher NUE (19%) while plots sown on 30th July showed the lowest NUE of 5%. These results are in line with [11] who reported a significant effect of early sowing on NUE as compared to late sowing. Increasing nitrogen fertilizer rates decreased NUE. Higher NUE (15%) was obtained from the low rate of nitrogen fertilizer (40 kg ha⁻¹) while the lowest NUE (7%) was obtained from the highest nitrogen level (120 kg ha⁻¹). These results are in also in agreement with the earlier findings [13], who reported that NUE was decreased by increasing nitrogen fertilizer rates. Local black cultivar recorded higher (12%) NUE as compared to local white cultivar which recorded the lowest (9%) NUE. Interaction of sowing date x cultivar x nitrogen indicated in (Fig. 6) showed that both cultivars obtained higher NUE when sown on 20th June. NUE decrease with increase in nitrogen levels, however early sown crop showed comparatively higher NUE as compared with other sowing dates.

4. Conclusion and Recommendations

It was concluded that sesame cultivar 'local black' sown on 20th June and supplied nitrogen @120 kg ha⁻¹ produced higher oil content, oil yield and seed yield with minimum incidence and severity (%) of *Alternaria* leaf blight. Therefore, sowing of sesame cultivar 'local black' on 20th June with the application of nitrogen at @120 kg ha⁻¹ is recommended in the agro-climatic conditions of Peshawar valley.

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