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Phenological and Morpological Traits of Sesame as Affected by Irrigation, Tillage Systems and Phousphours Levels

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Abstract
Despite the importance of sesame (*Sesamum indicum* L.) in the world, this crop has received only little research attention in Pakistan. Therefore, a field trail was conducted at New Developmental Farm of The University of Agriculture, Peshawar, Pakistan during summer 2012. The experiment was laid out in randomized complete block design with split plot arrangement having three replications. Irrigation interval (9 days, 18 days and 27 days) and tillage system (conventional tillage with cultivator, deep tillage with chisel plough and shallow tillage with MBP) were allotted to main plots, while phosphorus levels (0, 30, 60 and 90 kg ha^{-1}) were allotted to sub plots. Irrigation interval significantly affected all the parameters. Water supply at 9 days interval had delayed days to first flowering (50), maximum plant height (180 cm), branches plant^{-1} (10), capsule length (2.71 cm), leaves plant^{-1} (23) and stover yield (5667 kg ha^{-1}) as compared with other irrigation intervals but first capsule distance from ground is recorded greater in 27 days irrigation interval. Tillage system had significant effects on all the parameters, except days to first flowering, capsule length, first capsule distance from ground and leaves plant^{-1}. Conventional tillage produced maximum plant height (168 cm), branches plant^{-1} (9) and stover yield (5105 kg ha^{-1}) as compared with deep and shallow tillage system. Phosphorus application had also significantly affected all parameters except days to first flowering. Plots treated with 60 kg P ha^{-1} produced maximum plant height (178 cm), branches plant^{-1}(9), capsule length (2.68 cm), leaves plant^{-1} (21) and stover yield (5538 kg ha^{-1}) as compared with control plots but first capsule distance from ground is greater in control plot. Application of water at 9 days interval with conventional tillage method and treated with 60 kg P ha^{-1} had maximum plant height, leaves plant^{-1} and stover yield.
Keywords: Sesame (Sesamum indicum L.), tillage systems, irrigation intervals, phousphours levels, phenology, morphology

INTRODUCTION

Sesame (*Sesamum indicum* L.) member of the order tubiflera, family Pedaliaceae is a short-day plant. Sesame is considered as a drought tolerant crop and is therefore mainly grown as dry land crop especially in Indian sub continent where crop sowing time is dependent upon the availability of moisture. Sesame yield is highly variable depending upon the growing environment, tillage practices and availability of water (Qadeer, 1998). Sesame is an important edible oil seed crop however and its average yield was 500 kg ha^{-1} in Pakistan (MINFA, 2011). To enhanced sesame production, soil porosity is improved by conventional tillage practices and incorporation of residues. With improvement in porosity the aeration is enhanced which ensures adequate availability of oxygen to the plant root. (Bahadar et al., 2007) found that deep tillage (45 cm) practices improved root length and moisture availability as compared to shallow tillage. Deep tillage significantly enhanced the plant height and grain yield of sesame. Soil inversion by conventional tillage method usually led to an improvement in soil aeration, residue breakdown, organic P mineralization and the availability of P for crop use (Dinnes et al., 2002). Conventional tillage farming systems has been shown to improve crop establishment and growth through the amelioration of the adverse effects of high soil temperature, soil crusting and rapid drying of the soil surface. (Bulent et al., 2012). Recently, reduced and no-till methods have gained popularity. The employment of no-till or reduced tillage has been shown to be economical, useful for soil aggregation, and helpful in reducing soil erosion (Polat et al., 2006). Drought stress significantly decreased plant height, branches plant^{-1} and leaves plant^{-1} in sesame but it did not influence its seed weight plant^{-1} water deficit significantly affected the yield of auxiliary branches in sesame, so that its stover yield was higher under normal conditions as compared to under water stress conditions. To obtain optimum yield, it is necessary to supply enough moisture by irrigation in addition to improving soil fertility (Jouyban et al., 2007). Karaaslan et al., 2007 showed that extending the irrigation interval from 6 to 24 days decreased sesame stover yield from 4680 to 2604 kg ha^{-1}, respectively. Water stress is the most important factor affecting days to first flowering, leaves plant^{-1}, first capsule distance from ground and branches plant^{-1} especially in arid and semi arid regions. Ahmed et al., 1997 reported that the application of phosphorus up to 44 kg ha^{-1} increased significantly branches plant^{-1}, plant height, capsule length, leaves plant^{-1} and stover yield of sesame cultivar. Supply of phosphorus up to 60 kg ha^{-1} is usually associated with increased root density and proliferation, which aid in extensive exploration and supply of nutrients and water to the growing plant parts, resulting in increased growth and yield traits, there by ensuring more branches, leaves plant^{-}

[1] and dry matter yield (Shehu et al., 2010). Keeping in view the limitations under rainfed condition this experiment was conducted at the irrigated condition under the intensive farming system. To find out the most stabile tillage system, irrigation interval and phosphorus levels for higher yield at the agro-climatic condition of Peshawar.

MATERIALS AND METHODS

The study was carried out at New Developmental Farm of The University of Agriculture, Peshawar, Pakistan during kharif 2012. The site is located at (34^o 00' N, 71^o 30' E, 510 MASL). The experiment was laid out in randomized complete block design with split plot arrangement having three replications tillage systems (conventional tillage (15 cm) depth with cultivator, deep tillage (45 cm) depth with chisel plough and shallow tillage (30 cm) depth with MBP) and irrigation intervals (9 days, 18 days and 27 days) were allotted to main plots, while phosphorus levels (0, 30, 60 and 90 kg P ha^{-1}) were allotted to sub plots. A subplot size of 4 m x 3 m was used. Each sub plot was consisted of 10 rows having 40 cm row-to-row distance. Nitrogen was applied at the rate of 60 kg ha^{-1}, half at time of sowing and half before days to first flowering. Crop was sown at seed rate of 4 kg ha^{-1} using sesame cultivar local black. Days to first flowering were recorded in each subplot when first flowers appeared on plants. The time between flower initiation and date of seeding were considered as days to first flowering. Plant height (cm) was measured at harvesting stage through measuring tape from ground level to the top of the five randomly selected plants. Number of branches and leaves plant^{-1} were counted in ten plants randomly selected. Capsule length (cm) was measured at harvesting stage through measuring tape of ten randomly selected capsules. First capsule distance from ground (cm) was measured at harvesting stage through measuring tape from ground level up to first capsule. Data on stover yield was taken in four central rows in each subplot at harvest. Harvested crop was sun dried and weighed by using spring balance for calculating stover yield (kg sub plot^{-1}) and then converted into kg ha^{-1} by following formula.

$$\text{Stover yield (kg ha}^{-1}) = \frac{\text{Weight of plant materials in four rows (kg)}}{\text{No of rows x Row length x R-R distance}} \times 10{,}000 \text{ m}^2$$

Data collected were analyzed statistically according to the procedure relevant to RCB design. Upon significant F-Test, LSD test was used for mean comparison to identify the significant components of the treatment means (Jan et al., 2009).

RESULTS AND DISCUSSION

Days to first flowering

Mean value of the (Table 1) indicated that irrigation interval had significant effect on days to first flowering while tillage system, phosphorus levels and all the interaction were found not significant. Mean value of irrigation interval revealed that with increasing irrigation interval days to first flowering drastically decrease. Supplied of irrigation water with 9 days interval took significantly more (50) days while early days to first flowering (44) was recorded when supply irrigation water with 27 days interval. These results are in line with those of (Jouyban et al., 2007) who reported that increasing irrigation interval days to first flowering decreased. Irrigation interval from 6 days took more days to first flowering as compared to 18 days irrigation interval.

Plant height (cm)

Data regarding plant height showed that with increasing irrigation interval plant height decrease and taller (180 cm) plant height was recorded from 9 days irrigation interval which was (20 %) taller them from 27 days irrigational interval. These results are in line with those of (Jouyban et al., 2007) who reported that drought stress increased inter-plant competition as a result plant allocated more assimilates to the roots and less assimilates were allocated to shoots including stem. Therefore, plant height tended to decrease. Tillage system had significant effect on plant height. Maximum (168cm) plant height was recorded in CT while minimum (161 cm) plant height was noted in ST. These results are in line with the findings of (Polat et al., 2006) who reported that deep and shallow tillage produced dwarf plant when compared with conventional tillage. Plot treated with 60 kg P ha^{-1} produced taller (178 cm) plant height further increase in P level up to 90 kg ha^{-1} plant height decrease (2.30 %) while dwarf (142 cm) plant height was recorded in control plots. These results are in line with those of (Shehu et al., 2010) who reported that increased in plant height might be due to the stimulating effect of phosphorus on metabolic activity, cell division and expansion, leading to taller plant height up to 76 kg P ha^{-1}. Interaction between T x I x P revealed in (Fig. 1) that plant height increased with increasing P levels up to 60 kg ha^{-1} further increase in P level not significantly increase in plant height occur in all irrigation interval and tillage system but linearly increased in plant height was produced when give 9 days irrigation interval, with CT and treated with 60 kg P ha^{-1}.

Number of branches plant^{-1}

Mean value of irrigation interval revealed that maximum (10) number of branches plant^{-1} produced from 9 days irrigation interval which was (67 %) greater them from 27 days irrigational interval. These results are in agreement with the findings of (Jouyban et al., 2007) who reported that decrease (50%) branches plant^{-1} with increasing irrigation interval from 6 to 18 days. Tillage system had significant effect on number of branches plant^{-1}. Maximum (9) number of branches plant^{-1} was recorded in CT system while minimum (7) number of branches plant^{-1} was recorded in ST system. Similar results were reported by (Bulent et al., 2012) who found that (40%) branches plant^{-1} reduced by shallow tillage when compared to conventional tillage system. Plot treated with 60 and 90 kg P ha^{-1} produced (9) number of branches plant^{-1} while minimum (6) branches plant^{-1} was recorded in control plots. These results are in line with those of (Hafiz et al. 2012) who reported that branches plant^{-1} increased with increase of P level up to 76 kg ha^{-1} and this might be due to P enhances the meristemic activity consequently increased branches plant^{-1}. Interaction between I x T indicated in (Fig. 2) that branches plant^{-1} increased with decrease in irrigation interval but linearly increased was occurred in branches plant^{-1} when supplied water with 9 days interval and used CT system.

Capsule length (cm)

Data regarding capsule length is presented in Table 1 showed that with increasing irrigation interval capsule length decrease and maximum (2.71 cm) capsule length was recorded from 9 days irrigation interval which was (13 %) longer them from 27 days irrigational interval. These results are in line with those of (Jouyban et al., 2007) who reported that due to favorable conditions for plants growth under optimum irrigation (no-stress) conditions and so, distribution of assimilates to the lengthening of capsules and production of more seeds in them. Plot treated with 60 kg P ha^{-1} produced maximum (2.68 cm) capsule length further increase in P level up to 90 kg ha^{-1} capsule length decrease (0.38 %) while shorter (2.37 cm) capsule length was recorded in control plots. These results are in line with those of (Shehu et al., 2010) who reported that increased in capsule length with increase in P up to 76 kg ha^{-1}. Interaction between I x P indicated in (Fig. 3) that capsule length increased with increasing P level up to 60 kg ha^{-1} in all irrigation interval further increase in P level not significant increase in capsule length but linearly increased was recorded in capsule length when supplied water with 9 days interval and treated with 60 kg P ha^{-1}.

First capsule distance from ground (cm)

Mean value of irrigation interval revealed that first capsule distance from ground significantly increased with increasing irrigation interval so that the greatest first capsule distance from ground (35 cm) was obtained under the irrigation interval of 27 days which was (40 %) longer distance them from 9 days irrigational interval. It might be due to irrigation interval was reduced, the competition on resources particularly water started to decrease and more favorable conditions were provided for the growth hence branch-bearing was accelerated and the first capsule distance from ground decreased too. These results are in line with those of (Jouyban et al., 2007). With increase of phosphorus level first capsule distance from ground decrease significantly and therefore the greatest (33 cm) first capsule distance from ground was obtained in control plots. This could be due to sesame potential photosynthesis does not realize under P deficiency and so, fertile branches emerge later and first capsule distance from ground increases. These results are in line with the findings (Hafiz et al., 2012). Interaction between I x P indicated in (Fig. 4) that first capsule distance from ground increased with decrease P level and increase irrigation intervals.

Leaves plant^{-1}

Number of leaves plant^{-1} significantly reduced with increasing irrigation interval. Water Supplied with 9 days irrigation interval produced maximum (23) number of leaves plant^{-1} while minimum (15) number of leaves plant^{-1} was obtained from 27 days irrigational interval. Similar results were reported by (Jouyban et al., 2007) who reported that 6 days irrigation interval increase (47%) number of leaves plant^{-1}when compared with 18 days irrigation interval. It was due to the decrease in irrigation interval increased sesame vegetative growth, photosynthesis capacity and reduced inter-plant competition as a result number of leaves plant^{-1} eventually increased. With increase of phosphorus level number of leaves plant^{-1} increased significantly but beyond 60 kg P ha^{-1}further increase was stopped and therefore plots treated with 60 kg P ha^{-1} produced maximum (21) number of leaves plant^{-1} while minimum (16) number of leaves plant^{-1} was recorded in control plots. These results are in line with the findings (Rahman and Mahdi 2008) who reported that leaves plant^{-1} increased with increase P up to 44 kg ha^{-1} further increase in P level had not significant effect on number of leaves plant^{-1}. Interaction between T x I x P indicated in (Fig. 5) that number of leaves plant^{-1} increased significantly with increasing P level but beyond 60 kg P ha^{-1} further increased in leaves plant^{-1} was stopped in all irrigation interval and tillage system but linearly increased in leaves plant^{-1} was recorded when supplied water from 9 days irrigation interval with CT system and treated with phosphorus at the rate of 60 kg ha^{-1}.

Stover yield (kg ha^{-1})

Water supplied with 9 days irrigation interval produced maximum (5667 kg ha^{-1}) stover yield while minimum (3932 kg ha^{-1}) stover yield was obtained from 27 days irrigational interval. Similar results were reported by (Jouyban et al., 2007) who reported that 6 days irrigation interval increase (44%) stover yield when compared with 18 days irrigation interval. It was due to the decrease in irrigation interval increased sesame vegetative growth, photosynthesis capacity and reduced inter-plant competition as a result stover yield eventually increased. Tillage system had significant effect on stover yield. Maximum (5105 kg ha^{-1}) stover yield was produced in CT system while minimum (4376 kg ha^{-1}) stover yield was produced in ST system. These results are in line with those of (Bulent et al., 2012) who reported that higher stover yield was obtained when use conventional tillage as compared to deep and shallow tillage practices. With increase of phosphorus level stover yield increased significantly and therefore the highest level of phosphorus (60 kg ha^{-1}) produced maximum (5538 kg ha^{-1}) stover yield but statistically had not significant difference with 90 kg P ha^{-1} while minimum (2973 kg ha^{-1}) stover yield was recorded in control plots. These results are in line with the findings (Hafiz et al., 2012) who reported that P plays important role in enhancing translocation of metabolites which might be the reason for the increases observed in root density and proliferation which supply nutrients to plant as result stover yield increased. Interaction between T x I x P indicated in (Fig. 6) that stover yield increased significantly with increasing P level but beyond 60 kg P ha^{-1} further increased in stover yield was stopped in all irrigation interval and tillage system but linearly increased in stover yield was recorded when supplied water from 9 days interval with CT system and treated with 60 kg p ha^{-1}.

Table I. Days to first flowering, plant height (cm), number of branches plant^{-1}, capsule length (cm), first capsule distance from ground, leaves plant^{-1} and stover yield (kg ha^{-1}) of sesame as affected by irrigation intervals, tillage systems and phosphorus levels

Treatment	Days to first flowering	Plant height (cm)	No. of branches plant^{-1}	Capsule length (cm)	First capsule distance from ground (cm)	Leaves plant^{-1}	Stover yield (kg ha^{-1})
Irrigation interval (days)							
9	50a	180a	10a	2.71a	25c	23a	5667a
18	48b	163b	8b	2.58b	30b	19b	4611b
27	44c	150c	6c	2.40c	35a	15c	3932c
LSD (0.05)	0.33	0.25	0.15	0.03	1.54	1.28	25
Tillage systems							
Conventional (CT)	48	168a	9a	2.57	31	20	5105a
Deep (DT)	47	164b	8b	2.57	30	19	4729b
Shallow (ST)	47	161c	7c	2.56	30	19	4376c
LSD (0.05)	ns	0.25	0.15	ns	ns	ns	25
Phosphorus (kg ha^{-1})							
0	46	142d	6c	2.37c	33a	16d	2973c
30	47	163c	7b	2.53b	31b	19c	4892b
60	48	178a	9a	2.68a	29c	21a	5538a
90	48	174b	9a	2.67a	26d	20b	5524a
LSD (0.05)	ns	0.18	0.11	0.04	1.69	0.32	16
Interaction							
I x T	ns	ns	*	ns	ns	ns	ns
I x P	ns	ns	ns	*	*	ns	ns
T x P	ns	ns	ns	ns	ns	ns	ns
I x T x P	ns	*	ns	ns	ns	*	*

Means in the same category followed by different letters are significantly different at P ≤0.05 levels.

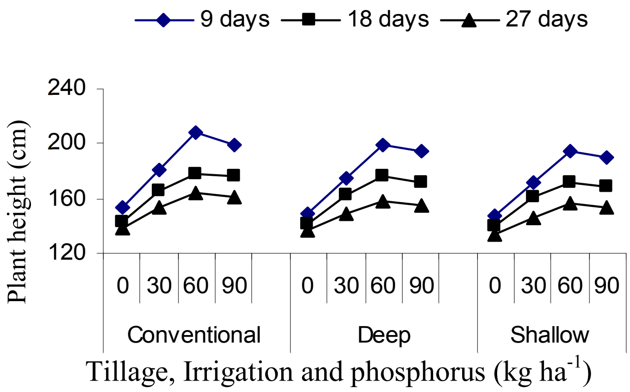

Fig. 1. Plant height of sesame is affected by tillage, irrigation and phosphorus levels.

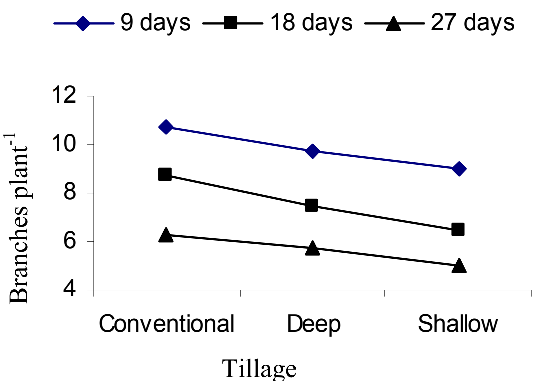

Fig. 2. Branches plant^{-1} of sesame is effected by irrigation and tillage.

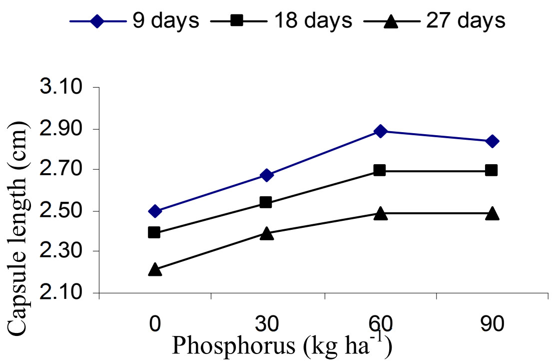

Fig. 3. Capsule length of sesame is affected by irrigation and phosphorus levels.

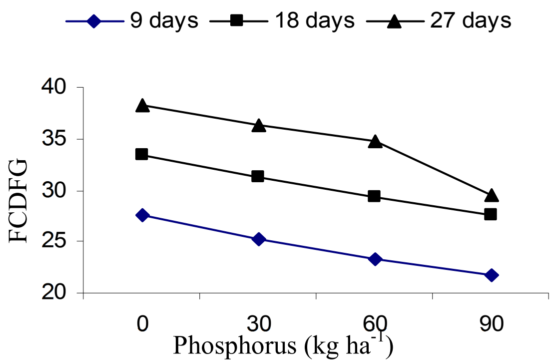

Fig. 4. First capsule distance from ground of sesame is affected by irrigation and phosphorus levels.

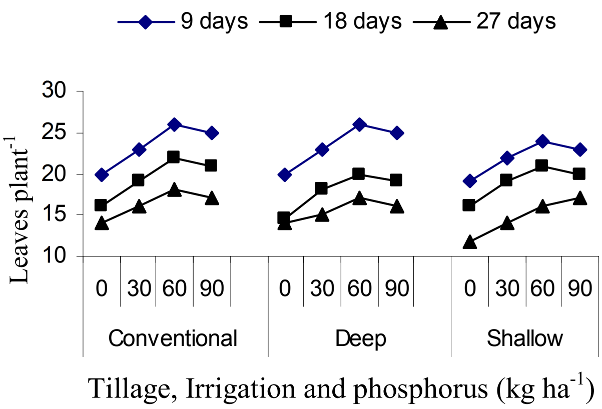

Fig. 5. Leaves plant^{-1} of sesame is affected by tillage, irrigation and phosphorus levels.

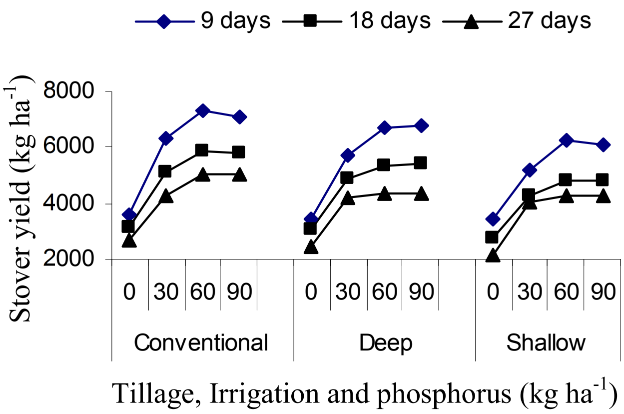

Fig. 6. Stover yield of sesame is affected by tillage, irrigation and phosphorus levels.

CONCLUSION AND RECOMMENDATIONS

Results from the current study indicated that supplied water with 9 days irrigation interval used conventional tillage system and phosphorus @ of 60 kg ha^{-1} produced maximum days to first flowering, plant height, branches plant^{-1}, leaves plant^{-1} and stover yield significantly and therefore, it is recommended to use irrigation interval of 9 days with conventional tillage system and application of phosphorus at the rate of 60 kg ha^{-1} under the conditions of the current study area.

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