Pheno-Morphological Traits of Mungbean as Influenced by Phosphorous and Tillage under Irrigated and Un-irrigated Conditions

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ABSTRACT

Phosphorus (P) deficiency is one of the major growth limiting factors throughout the world and especially in Pakistan. Field experiment was conducted to study the effect of P levels and tillage depths (cm) on phenology and growth of mungbean (*Vigna radiate* L. Wilczek, cv. NM-54), under irrigated and un-irrigated conditions. Two separate fields were used for irrigated and un-irrigated conditions at New Developmental Farm of The University of Agriculture Peshawar, Pakistan during summer 2012. The experiment in each field was laid out in randomized complete block design with split plot arrangement having three replications. Three tillage depths (45, 30 and 15 cm) were allotted to main plots, while P levels (0, 30, 60 and 90 kg P ha⁻¹) were allotted to sub plots. The results revealed that P application at the two higher rates (60 and 90 kg P ha⁻¹) hastened days to flowering (46 days each) and pod formation (55 & 54 days, respectively), increased plant height (73 & 68 cm, respectively), number of leaves plant⁻¹ (19 each) and straw yield (1859 & 1992 kg ha⁻¹, respectively). Plots tilled 45 cm deep delayed flowering (48 days) and pod formation (57 days). However, tillage depths had no significant effect on other growth parameters and straw yield. Irrigated plots took more days to flowering (48 days) and pod formation (57 days), produced taller plants (69 cm), more number of leaves plant⁻¹ (18) and straw yield (1889 kg ha⁻¹) when compared with un-irrigated plots. In the light of these results, we concluded that P application at the rate 60 kg P ha⁻¹ was considered the most suitable P rate for improving mungbean productivity under irrigated and un-irrigated condition. Deep tillage (45 cm) was considered more beneficial in terms of higher mungbean productivity under un-irrigated condition, while shallow tillage (15 cm) was better under irrigated condition in the study area.

Keywords: Irrigation and tillage systems, Phenology and growth of mungbean, Phosphorous

Introduction

Mungbean (*Vigna radiata* L., Wilczek), a member of the family leguminosae grown mainly on dry land, is an important kharif season (summer) crop of Pakistan. For most arid and semi-arid soils, wherever cropping is practiced, the soil phosphorus reserves have been depleted and the amounts of available phosphorus are usually inadequate for satisfactory yield. The use of balanced fertilization as well as proper tillage practices can enhance the yield of mungbean. During plant growth P favors reproductive stage and hastens the maturity. The most essential function of P in plant growth is in energy storage and transfer. Phosphorus is an important structural component of a wide variety of bio-chemicals including nucleic acid, nucleotides, phosphor-proteins, phospholipids and sugar phosphate [1]. Various levels of applied P significantly affected the growth and yield components of mungbean. Phosphorus level of 90 kg ha⁻¹ produced the maximum grain yield [2]. Phosphorus (P) is concentrated near the soil surface in response to reduced tillage. Among the major nutrients phosphorus is required in greater quantity by legumes. Phosphorus has positive effect on crop quality as increases protein content of mungbean [3]. Phosphorus applications increased green gram seed yield and protein content [1]. Phosphorus is immobile in soil therefore its unavailability is affecting growth of plants in addition

to its low levels in our soils. More than 90% of Pakistani soils are deficient in phosphorus [4]. In phosphorus deficient situation become worst in dry land condition where there is always shortage of moisture that effect fertilizer efficiency and successful crop production.

Tillage is the mechanical manipulation of soil. Tillage practices are done to prepare seedbed for sowing, improve soil physical conditions and weed control. Frequent tillage for the purpose of intercepting maximum rainfall and conserving moisture for the subsequent crop has led to degradation of soil. Conventionally tilled soil is easily eroded by water in winter and by wind in summer, and soil compaction may cause hard pans and reduce water infiltration. Significance of reduced tillage operation has recently been recognized as it increases organic carbon (C), nitrogen (N) and soil water content as compared to conventionally tilled soils [5]. As tillage is reducing, soil bulk density and soil strength increases, air-filled porosities and soil temperature decreases, especially early in the growing season [3].

In most rainfed area of Pakistan, due to poor soil fertility and low annual rainfall the farmers usually grow crops and then leave the soil fallow. They conserve moisture from the summer rain water in the soil until the time of sowing of a winter crop by combination of tillage practices. As the population of

Pakistan is increasing rapidly, the demand for food, fiber etc. is increasing. To meet the increasing demand for food, it will not be feasible to leave the land fallow. Under such situations, appropriate cropping system must be adopted to sustain soil fertility and improve crop productivity [6]. Many researchers in Pakistan now advise the farmers to follow the principle of conservation agriculture in rainfed area for enhancing the soil organic matter and efficient utilization of nutrients and water. However, there is very little scientific information available as to how the crop residues and no-tillage practices will affect N fixation and water use efficiency. Keeping in view the importance of phosphorus levels, tillage depths and

water availability, therefore the current experiment was designed to investigate the influence of different P levels and tillage depths for improving growth of mungbean under irrigated and un-irrigated conditions.

Materials and Methods

Field experiments were conducted to investigate effects of P levels (0, 30, 60 and 90 kg P ha⁻¹) and tillage depth (45, 30 and 15 cm) on phenology and growth of mungbean at the New Developmental Farm of The University Agricultural Peshawar, during summer 2012. The weather data of the experimental site during mungbean growing period is given in Table 1.

Table-1: Temperature (°C), rainfall (mm), and relative humidity (%) of the experimental site for the growing period of the mungbean crop (June-October 2012)

Month	Mean temperature (°C)		Mean rainfall (mm)	Relative Humidity (%)
	Minimum	Maximum		
June	22	43	0	35
July	27	41	100	56
August	26	38	100	59
September	23	35	110	70
October	15	31	100	56

Metrological station: Pakistan Forest Institute Peshawar.

Two separate experiments were conducted under irrigated and un-irrigated conditions. Each experiment was laid out in randomized complete block design with split plot arrangements using three replications. Three tillage depths (45, 30 and 15 cm deep) as main plots and four P levels (0, 30, 60 and 90 kg P ha⁻¹) as subplots factors were used. Each replication consisted of 12 treatments. A sub-plot size of 5 x 4 m² having 10 rows (4 m long and 50 cm apart) was used. Tillage implements chisel plough; mould board plough and cultivator were used for 45, 30 and 15 cm deep tillage respectively. A uniform basal dose of 30 kg N ha⁻¹ as urea was applied and mixed with the soil during seedbed preparation to all plots. Phosphorus in the form of single super phosphate (18 % P₂O₅) was applied at the time of sowing. In irrigated experiment, irrigations were applied according to the crop need. However, under un-irrigated experiment, one irrigation was applied for seedbed preparation only and the crop completed its life cycle with rainfall water. Data were recorded on days to flowering, days to pod formation, plant height, leaves plant⁻¹, and straw yield (kg ha⁻¹). Data were subjected to analysis of variance (ANOVA) according to the methods described by [7], and means between treatments was compared by least significant difference ($P \leq 0.05$).

Results and Discussion

Phenology (Days to flowering and pod formation)

Phenology was significantly affected by phosphorous (P) levels, tillage depth (T) and irrigation (I) (Table 2).

In case of P, plots treated with 0 kg P ha⁻¹ delayed flowering (49 days) and pod formation (58 days). Early flowering (46 days) and pod formation (54 days) were recorded with 90 kg P ha⁻¹. Decrease in P levels caused delay in phenological development in mungbean. These results are supported by [8] that increased in the P amount minimized (earlier) days to phenology. Among tillage depths, maximum days to flowering (48) and pod formation (57 days) were recorded with 45 cm deep tillage system. The deep tillage system might have increased water storage in the soil that probably delayed phenological development. Irrigated plots delayed flowering (48 days) and pod formation (57 days), while early flowering (46 days) and pod formation (55 days) were recorded in un-irrigated plots. In case of T x I interaction (Fig. 1 & 2), delay in phenology was observed with the increase in tillage depth under un-irrigated condition, which might be due to water conservation with deep tillage. However, under irrigated condition, variation in tillage depth had no or less effect on phenology. These results indicated that moisture stress causes early flowering and pod formation in mungbean. These results are in line with those of [9] that water stress conditions shift plant early from vegetative to reproductive stage.

Growth (plant height and leaves plant⁻¹)

Plant growth was significantly affected by irrigation and phosphorous (Table 2). Tillage depths had no significant effect on plant height and number of leaves

plant⁻¹. Increase in P level improved mungbean growth and therefore maximum plant height (73 cm) and leaves plant⁻¹ (19) were observed with 60 kg P ha⁻¹ being at par with 90 kg P ha⁻¹. Phosphorous control plots produced shorter plant heights (58 cm) and number of leaves plant⁻¹ (15). The results of [1] supported our findings by reporting taller plants with increase in the amount of phosphorous. However, [10] reported decrease in plant height and increase in number of leaves plant⁻¹ with increase in P levels. The contradiction in plant height might be due to differences in genetic makeup of the varieties. Irrigated plots produced taller plants (69 cm) than un-irrigated plots (63 cm). Similarly, more leaves plant⁻¹ (18) was recorded in irrigated plots than un-irrigated plots (17). Interaction of T x I revealed that increase in tillage depth under un-irrigated conditions increased plant height and leaves plant⁻¹ (Fig. 3 & 4 respectively). But under irrigated condition, increase in tillage depth reduced plant height and number of leaves plant⁻¹. However, the increase in growth under un-irrigated condition was more than the reduction under irrigated condition. These findings are supported by [9] who reported enhancement in growth with proper nutrients uptake due optimum irrigation and soil physical conditions.

Straw yield

Straw yield of mungbean was significantly affected by phosphorous levels, irrigation as well as interaction of T x I and P x T x I (Table 2). However, tillage depth had no significant effect on straw yield. Increase in P level increased straw yield and maximum straw yield (1992 kg ha⁻¹) was produced with 90 kg P ha⁻¹ being at par with 60 kg P ha⁻¹ (1859 kg ha⁻¹). Minimum straw yield (1501 kg ha⁻¹) was recorded in P control plots. In

case of irrigation, irrigated plots produced higher straw yield (1889 kg ha⁻¹) than un-irrigated plots (1663 kg ha⁻¹). Interaction of T x I indicated that decrease in tillage depth under irrigated and increase in tillage depth with un-irrigated conditions increased straw yield (Fig. 5). Interaction of P x T x I indicated that increase in P level under both irrigated and un-irrigated conditions increased straw yield (Fig. 6). The interaction also revealed that decrease in tillage depth under irrigated condition and increase in tillage depth under un-irrigated condition increased straw yield. Yield was affected under drought stress condition and it was reduced by 22.69% compared with non-stress condition [11]. Moisture stress reduces yield of mungbean and maximum negative effects of drought obtained with once irrigation during growth season [12]. Straw yield of mungbean was increased with the increase in phosphorous levels. These results are in line with the findings of [10], who reported that increase in P level increased mungbean yield.

Conclusion

Increase in phosphorous level up to 60 kg ha⁻¹ enhanced phenology, improved growth and straw yield of mungbean. Increase in tillage depth under un-irrigated and decrease in tillage depth under irrigated condition performed better in terms of improving growth and straw yield of mungbean. On the basis of our results it was recommended that phosphorous application at the rate of 60 kg P ha⁻¹ could improve growth and yield of mungbean under both irrigated and un-irrigated condition. Deep tillage (45 cm) system under un-irrigated condition (moisture stress) and shallow tillage (15 cm) under irrigated condition (no moisture stress) had positive impact on growth and straw yield of mungbean in the study area.

Table-2: Days to flowering & pod formation, plant height, leaves plant⁻¹ and straw yield as affected by phosphorous levels and tillage systems under irrigated and un-irrigated conditions.

Phosphorous (kg ha ⁻¹)	Days to flowering	Days to pod formation	Plant height (cm)	Number of leaves plant ⁻¹	Straw yield (kg ha ⁻¹)
0	49a	58a	58c	15c	1501c
30	48b	57b	64b	17b	1751b
60	46c	55c	73a	19a	1859ab
90	46c	54d	68ab	19a	1992a
LSD (p<0.05)	0.09	0.09	5.64	1.56	144
Tillage depth (cm)					
45	48a	57a	65	17	1759
30	47b	56b	65	18	1799
15	47b	56b	68	18	1769
LSD (p<0.05)	0.43	0.43	ns	ns	ns
Irrigation					
Irrigated	48a	57a	69a	18a	1889a
Un-irrigated	46b	55b	63b	17b	1663b
	*	*	*	*	*
Interactions					
T x I	*	*	*	*	*
P x T x I	ns	ns	*	*	*

Means in similar columns with different alphabets differ significantly from each other at p<0.05 using LSD test.

Where; * = Significant at 5% level of probability.
ns = Non-significant.

Fig. 1. Interaction of T x I for flowering.

Fig. 2. Interaction of T x I for pod formation.

Fig. 3. Interaction of T x I for plant height.

Fig. 4. Interaction of T x I for leaves plant⁻¹.

Fig. 5. Interaction of T x I for straw yield

Fig. 6. Interaction of P x T x I for straw yield

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