SEED YIELD OF MUNGBEAN UNDER LATE SEEDING: EFFECT OF
PHENOLOGICAL DAYS AND DRY MATTER DISTRIBUTION.

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ABSTRACT
In order to ascertain the effect of phenology and dry matter distribution in different plant parts on seed yield of mungbean under late seeding condition, sixteen mungbean genotypes were planted during 2nd week of September and phenology dry matter buildup and its distribution amongst plant parts were studied. With correlation and path analysis it was concluded that mungbean yield under late seeding condition is highly influenced by seed filling period and dry matter allocation in leaves during flowering as well at maturity.

Key words: Late seeding, Mungbean, Phenological days.

INTRODUCTION
Mungbean [Vigna radiate (L) Wilczek] is one of the important crops with wide adaptability in India. Except peninsular region, mungbean is generally grown as rainy season crop and is sown with the onset of monsoon. However, under intensive cropping system, where fields are occupied for most of the time in year delay in one crop lead to delay in succeeding crop, or delay in monsoon setting may also delay in mungbean, sowing. Under such situation the crop does not perform optimally resulting in poor yield. It has been advocated that planting time is the most important non-monetary input affecting growth and yield of crop and this effect was attributed mainly to the changes in environmental condition (Panwar and Sharma, 2004). The poor yield with delay in seeding date has been attributed mainly to reduction in days to flowering, maturity and dry matter production (Berhe, 1998, Rajender et al. 1993, Sliman, 1993, McDonald et al. 1994, Kurmawanshi et al. 1994, Khalil et al. 2010). It has been pointed out that effect of late seeding on soybean varies with location (Hoeft et al. 2000, Naeve et al., 2004) and the effect is mainly due to shortening of reproductive phase (Kantolic and Slafer, 2001). It has also been reported that in chickpea during late seeding (45 days late to normal) yield had substantial positive effects for total dry matter during pre and post flowering periods (Ganguly and Bhattacharya, 2001). Ravi (1984) reported that high yielding greengram genotypes were more efficient in the accumulation and partitioning of dry matter in the reproductive structures.

Further, yield variation in grain legumes has been ascribed to the interactive effects of traits involving morphological, physiological or temporal during pre and post flowering periods with environmental factors (Summerfield et al. 1980). However, effect(s) of various processes differ with growth stages for yield (Sinha and Khanna, 1975). Under such situation, there is great need to testify the effect(s) of the physiological trait(s) viz., phenology and dry matter buildup and distribution, on the mungbean seed yield under late seeding condition. Therefore the present study has been initiated to have an insight of the mungbean seed yield under late seeding condition.

MATERIALS AND METHODS
Sixteen mungbean [Vigna radiata (L.) Wilczek] genotypes viz., PDM 11, PDM 54, PDM 139, IPM 03-1, IPM 99-125, Asha, Narendra mung-1, K 851, HUM 1, MUM 2, ML 729, Pusa vishal, Pant M-4, SML 668, Pusa 99 and V 3518 were planted in 2nd week of September, 2007 and 2008
in field under irrigated condition at the research farm area of Indian Institute of Pulses Research, Kanpur (26° 24'15" N, 80° 24'36" E at an altitude of 126 m above mean sea level). The soil of the experimental site was Inceptisol having low available nitrogen (150 kg N/ha), medium available phosphorus (22 kg P$_2$O$_5$/ha) and medium in available potassium (180 kg K$_2$O/ha). Planting was done on seven rows of 5 m row long keeping plant to plant distances as 10 cm and row to row distances as 30 cm, done under randomized block design (RBD) with three replications. The crop was raised in accordance to standard agronomical recommendations and proper plant protections were adopted as and when required. Crop was monitored for various phenological days (days to flowering, maturity and seed filling period), dry matter accumulation in leaf stem and pod (g/plant) at various growth stages viz., flowering and maturity. Dry matter of different plant parts were observed by randomly selecting five plants, separating the plant parts and dry them at 80°C in air dry oven for constant weight. Seed yield at maturity was also observed and expressed as kg/ha.

Data thus collected during 2007 and 2008 were tested for their homogeneity for each year, were pooled over years, and were subjected to standard statistical procedures for test significance. The minimum, maximum and values of the traits their variances, critical differences (CD) and per cent coefficient of variation (CV) were given. Coefficients of correlation of each trait were estimated with other traits under study in accordance to Senedecor and Cochran (1978) and we further partitioned for their respective direct and indirect effects using path analysis in accordance to Dewey and Lu (1959).

**RESULTS AND DISCUSSION**

Descriptive statistical estimation for different traits at flowering in mungbean genotypes under late seeding condition revealed that there were wide differences between minimum and maximum values in all the traits under study and they exhibited significant genotypic differences, excepting leaf dry matter at flowering (Table 1). From the mean values it was apparent that there were drastic reductions in dry matter accumulation in leaf and stem at maturity stage as compared to flowering stage. Although the levels of dry matter accumulation were reduced, the genotypic differences were maintained at maturity stages. The difference between minimum and maximum seed yield was noted to be quite wide (185.73 and 631.22 kg/ha, respectively). Genotypic differences in physiological traits, including dry matter partitioning into different plant parts at different crop growth stages were in confirmation to the earlier reports in mungbean (Bhattacharya, 1996, Vijaylaxmi and Bhattacharya, 2006), urdbean (Bhattacharya, 2000). Reduction in dry matter in leaves as well as in stem, during maturity stage in comparison to flowering stage, could be seen as loss of leaves during maturity and as translocation of dry matter from stem to developing seeds during seed filling period.

The estimated values of coefficient of variation were also of moderate magnitude. Coefficients of correlation among different traits, under study, exhibited that not all the traits were correlated with each other, nor mungbean seed yield under late seeding had significant correlation with all other traits under study (Table 2). None of the parameters in mungbean expressed significant correlation with seed yield under late seeding.
condition. Different phenological days were significantly correlated with each other. Leaf and stem dry matter had significant negative correlation with days to flowering, whereas they were positively and significantly correlated (Table 2). Phenological days showed significant correlations amongst themselves and it can be attributed that each and every phenological days are interlinked. Significant negative correlation of stem and leaf dry matters at flowering stage with days to flowering may be due to the fact that since the crop is late seeded crop, so longer vegetative period expose the plants to more adverse environmental conditions as has been pointed out by Board and Harville (1998), Zhang et al. (2010). Mungbean seed yield failed to express any significant correlation with any traits under study and it can be said that either the traits, under study, are masking each other in expressing their relationship with seed yield or they do not have any direct relationship with mungbean seed yield under late seeding condition.

When coefficients of correlation were further partitioned for their direct and indirect effects for mungbean seed yield under late seeding condition, it was apparent that all the direct effects were of lower magnitudes (Table 3). Positively maximum direct effect was seen through seed filling period (0.639) followed by leaf dry matter at maturity (0.328) while highest negative direct effect for yield under late seeding was seen through pod dry matter at maturity (-0.468) followed by leaf dry matter at flowering (-0.345). Maximum positive indirect effect of seed yield was seen for days to maturity through seed filling period (0.374), whereas maximum negative indirect effect was seen for days to flowering through seed filling period (-0.330). The residual correlation was estimated to be relatively higher (0.730) as compared to direct and indirect effects of the traits. Maximum direct effect of seed filling period for seed yield is self explained as more number of days for seed filling will lead to higher seed yield. However, positive effect of leaf dry matter at maturity is not well understood, because higher leaf dry matter at maturity mean less of translocation from leaves

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Residual = 0.730

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1 = Days to flowering, 2 = Days to maturity, 3 = Seed filling period, 4 = Leaf dry matter at flowering, 5 = Leaf dry matter at maturity, 6 = Stem dry matter at flowering, 7 = Stem dry matter at maturity, 8 = Pod dry matter at maturity, and 9 = Seed yield, * and ** are significant at 5 and 1%, respectively.
to developing seeds and low yield, means a negative relationship. The negative direct effect of days to maturity probably points out to the fact more number of days taken will lead to exposure of the crop to more adverse environmental condition, because the crop is late seeded. The negative direct effect of leaf dry matter during flowering could possibly be attributed to the fact that higher dry matter allocation leads to less number of flower retention as has been pointed out by Bhattacharya and Sharma (2001) for normal and late seeded pigeonpea. The presence of relatively higher residual correlation probably points out the presence of one or more traits which are influencing mungbean seed yield either directly or indirectly and need to be explored.

With the foregoing result and discussion it can be said that physiological traits, under study, had genotypic differences and seed yield of mungbean under late seeding condition is highly influenced by seed filling period and dry matter allocation in leaves during flowering as well as at maturity. However, presence of relatively higher residual effect warrant more in-depth study in future involving more of morphological, physiological and biochemical parameters for mungbean yield structure under late seeding condition.

REFERENCES


